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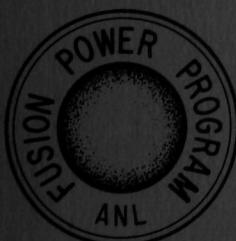
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MACKLIB-IV
A Library of Nuclear Response Functions
Generated with the MACK-IV Computer Program
from ENDF/B-IV

by

Y. Gohar and M. A. Abdou



FUSION POWER PROGRAM

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March 1978

Results reported in the FPP series of memoranda
frequently are preliminary and subject to revision.

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MACKLIB

A Library of Nuclear Response Functions Generated with the MACK-IV Computer Program from ENDF/B-IV

Y. Gohar and M. A. Abdou
Fusion Power Program

ABSTRACT

A new library, MACKLIB-IV, of processed nuclear data for neutronics analysis of nuclear systems has been generated. The library was prepared using the new version of the MACK code, MACK-IV, and nuclear data from ENDF/B-IV. The library includes all nuclear response functions for all materials presently of interest in fusion and fusion-fission hybrid applications for 49 materials. The new library is a significant upgrade from the earlier version, MACKLIB.

MACKLIB-IV employs the CTR energy group structure of 171 neutron groups and 36 gamma groups. A retrieval computer program is included with the library to permit collapsing into any other energy group structure. The library is in the new format of the "MACK-Activity Table" which uses a fixed position for each specific response function. This permits the user when employing the library with present transport codes to obtain directly the nuclear responses (e.g. the total nuclear heating) summed for all isotopes and integrated over any geometrical volume. The response functions included in the library are neutron kerma factor, gamma kerma factor, gas production and tritium-breeding functions, and all important reaction cross sections. Pertinent information about the library and a graphical display of six response functions for all materials in the library are given.

INTRODUCTION

This report describes a new version of the MACKLIB⁽¹⁾ library, MACKLIB-IV. The library includes the nuclear response functions, e.g. kerma-factors, gas production, and tritium breeding cross sections, for a large number of materials of interest in fusion and fission applications. MACKLIB-IV was generated with the new version of the MACK computer program, MACK-IV,⁽²⁾ employing basic nuclear data from ENDF/B-IV.⁽³⁾ Although the basic structure of MACKLIB-IV is similar to the earlier version, the new library is given in the new⁽²⁾ versatile format of the "MACK-Activity-Table". This format allows considerable flexibility in calculating the nuclear responses internally with presently available transport codes.

A list of the 49 materials for which nuclear response functions are given in MACKLIB-IV is shown in Table I. The response functions included in the library are given in the format of the "MACK-Activity-Table" shown in Table II. The library is in the CTR energy group structure⁽⁴⁾ of 171 neutron groups and 36 gamma groups shown in Tables III and IV, respectively.

Pertinent information about the library is given in the rest of the report. A general-purpose retrieval program is described. Graphical displays of six response functions for all materials in the library are given in Appendix A.

MACKLIB FORMAT

The library is distributed in the "MACK-Activity-Table" format. For each material there is one data set. Within each data set there is an activity table for each energy group. This table consists of IHM positions. The type of information given in each position is shown in Table II. For example, the neutron kerma factor always appears in position 2 while the tritium-production cross section always appears in position 7.

The distributed library is a coupled neutron-gamma structure with 171 neutron groups and 36 gamma groups. The retrieval program described later in this report permits collapsing into a smaller number of groups. If we denote the number of neutron groups by IGN and the number of gamma groups as IGG, then the data set for one material consists of IGM activity tables where $IGM = IGN + IGG$. Tables for groups 1 through IGN contain the response functions for neutron interaction while the tables for groups IGN+1 through IGM contain the response functions for gamma interaction. Thus, in reference to Table II, it follows that position 3 which is reserved for gamma kerma factor is always zero in the tables for groups 1 through IGN. One can also note that for groups IGN+1 through IGM only positions 1, 3, 32, and 34 have nonzero entries. For position 1, the neutron kerma factors appear in groups 1 through IGN and the gamma kerma factors appear in groups IGN+1 through IGM. Similar observations can be made about position 32.

The library is distributed in card image format (80 characters per record). All numbers are in FIDØ format (see, for example, ANISN manual⁽⁵⁾).

MACKLIB UTILIZATION

MACKLIB can be used with any neutron and gamma-ray flux spectra to calculate the spatial distribution of neutron, gamma, and total heating, rates of atomic displacements, tritium breeding ratio, gas production, and other reactions of interest. Since the response functions in MACKLIB are flux- and density-independent, the library can be utilized for calculating the nuclear responses in one-, two-, and three-dimensional geometries for any spatial distribution of mixtures of materials.

One way to calculate the nuclear responses is to employ a simple computer program to carry out the summation over energy groups of the product of the flux and the appropriate response function from MACKLIB. Another convenient way is to mix the "MACK-Activity-Tables" explicitly with the "regular transport" multigroup cross sections via the mixing tables in the transport code employed to predict the flux solution (e.g., via the 10\$, 11\$, and 12* arrays in ANISN⁽⁵⁾ or the equivalent in DØT⁽⁶⁾). The number density for each activity table should be the appropriate number for the material multiplied by a small (e.g.

10^{-15}) fixed number, f. This multiplication factor ensures that the transport cross sections are not significantly altered. The reaction rates and other integrated responses calculated directly by the transport codes will be the true values multiplied by f.

For this procedure to be successful the group structure of the multigroup transport cross sections must be identical to that of the MACK-Activity-tables. Furthermore, the length of the cross-section table, IHM (number of positions per group), must be the same in the transport cross sections and the activity tables. Notice that in MACKLIB-IV each response function has a fixed position for all materials; and, therefore, response functions for a mixture of materials is readily obtainable by mixing the MACK-Activity-tables for the materials in exact analogy to mixing the "regular transport" multigroup cross sections.

RESPONSE FUNCTIONS

The response functions included in MACKLIB-IV are listed in Table II. All the neutron response functions except the atomic displacement cross sections were generated with the MACK-IV⁽²⁾ computer program using basic nuclear data from ENDF/B-IV. A weighting function similar to that described in Ref. 4 was employed for generating the 171 neutron group data from one thousand energy points. The gamma kerma factors were generated with the SMUG⁽⁷⁾ computer program. The atomic displacement cross sections in position 4 were taken from the work of Doran.⁽⁸⁾ The displacement cross sections were available only for the materials listed in Table V. The displacement energies assumed in generating the displacement cross sections for the various materials are given in Table V. Position 5 in the activity table, labelled "Displacement Cross Section B," currently has no information and the position is reserved for the convenience of the user in entering new data, since there is considerable uncertainty in displacement cross sections at present.

The integrated responses for positions 1, 2, and 3 yield the neutron, gamma, and total heating, respectively. The entry in position 7 (total tritium production cross section) integrated over space and energy variables yield directly the tritium breeding ratio if the neutron source strength is normalized to unity.

Positions 23 through 31 include the contribution to the neutron kerma factor from individual reaction types.⁽²⁾ Such individual contributions are not available for materials whose neutron kerma factors were generated using the direct gamma-production path⁽²⁾ of MACK-IV.

The average energy (taken as the mid-point energy) of each neutron group is included in positions 32 and 33 for groups 1 through IGN. The average energy of each gamma group is given in positions 32 and 34 for groups IGN+1 through IGM. Positions 32, 33, and 34 can be utilized efficiently to obtain the integrated energy flux and energy leakage.

Positions 35 through IHM (IHM = IGM+3) are filled with zeroes. Notice that a zero value is entered for each position at each group where a response function is not applicable or not available. For example, positions 3 and 34 will always have zero entries for all groups 1 through IGN and actual values for groups IGN+1 through IGM. As another example, positions 13 and 14 [(n,3n) and (n,f) cross sections] are filled with zeroes for all groups for materials such as hydrogen, helium, and lithium.

DECAY AND FISSION ENERGIES

The contribution to nuclear heating from the radioactive decay of the reaction products has been discussed in Refs. 2 and 9. The neutron kerma factors in MACKLIB-IV include the contribution to neutron heating from radioactive decay (primarily β^- and β^+) of the reaction products. This is an approximation which is shown^(2,9) to be reasonable for the applications in which MACKLIB-IV is expected to be employed. It should be noted that this approximation is not valid for other applications such as certain types of health physics calculations.

The average beta decay energies were prepared using the tables in Ref. 2. Decay modes, half-lives, branching ratios, and maximum beta energies were determined from data in Refs. 10 and 11. The decay energy for each reaction included in MACKLIB-IV calculations is shown for the various materials in Appendix B.

The local energy deposition per fission reaction is given by the sum of the final kinetic energies of the fission fragments. Detailed studies show that the kinetic energy of the fission fragments is not sensitive to the incident

neutron energy at low energies. However, it is expected that the kinetic energy of the fission fragments has an important energy dependence for incident neutron energies in the 5 to 20 MeV. Since reliable data on such energy dependence is lacking we have adopted values⁽¹²⁾ for the kinetic energy of the fission fragments that are independent of the incident neutron energy. These values are shown in Table VI.

ALTERNATE FORMAT AND ADDITIONAL DATA

The data in MACKLIB-IV is also available in a structured format different from that of the MACK-Activity-Table. In this alternate format, each material has a set of arrays; each array contains the data for one response function. Each array is preceded by two title cards; the first is for the material identification and the second is for the response function title. Each response function array contains only a number of entries equal to the number of neutron groups (171 groups for MACKLIB-IV). This alternate format is useful for users who do not wish to work with the fixed format of the MACK-Activity-Table.

Gamma-production matrices generated concurrently with MACKLIB-IV are also available. The use of these gamma-production cross sections is not a requirement for the adequate use of the MACKLIB-IV, but it would ensure preserving the energy in all phases of heating calculations for those materials whose ENDF/B evaluations do not consistently preserve the energy.

RETRIEVAL PROGRAM

A retrieval program has been written to perform several functions. The program reads the library in FIDØ card image format (the distribution format for the library), performs the user's requests, and writes a new library in FIDØ card image format or ANISN binary tape.

INPUT INSTRUCTIONS

CARD No. 1

FØRMAT (2A4,3I6)

I1,I2	Define the program function with eight characters in columns
(1) ADD	Add new material(s) to the existing library.
(2) REPLACE	Replace specific material(s) in the existing library.
(3) DELETE	Delete certain material(s) from the existing library.
(4) COLLAPSE -	Collapse the library from 171 neutron, 36 gamma groups to a broader group structure.
(5) MIX	Mix certain material(s) from the existing library to generate a mixture(s).
(6) ANISN _V UF	Generate an output library in unformatted ANISN tape library.
IN	Unit number for the input library.
I0U	Unit number for the output library in ANISN card image format except for function number six.
INM	Unit number for the input material(s) to be added or replaced in the input library on unit IN.

CARD NO. 2

FØRMAT (15I5)

This card is input for replace, delete, or collapse function only.

N Number of materials to be replaced, deleted, or collapsed from the library.

IMAT(N) ID number of the material(s) to be replaced or deleted from the library. A list of ID numbers for the library are given in Table I. The MAT number has been used as ID number for the materials in the library.

CARD NO. 3 (ANISN Free Format)

These data are needed for the collapse function only. ANISN integer array of 207 values gives the broad-group number by fine group. As an example, if the 207 group will be collapsed to four-neutron group and two-gamma group structures, this array will be as follows:

1\$S 35R1 40R2 35R3 61R4 18R5 18R6 T

This means the first 35 fine groups will be group No. 1 and the next 40 fine groups will be the second group as illustrated in the data card.

CARD NO. 4 FØRMAT (3I5)

IW Weighting option.

- (1) Flat weighting function for neutron and gamma groups.
- (2) 1/E weighting function for neutron groups and flat weighting function for fine gamma groups.
- (3) Input weighting function for neutron groups and flat weighting for gamma groups.
- (4) Input weighting functions for neutron and gamma groups.

ITA Table length for each group (ITA \geq number of groups + 3).

NNN Number of broad groups (neutron plus gamma).

CARD NO. 5 FØRMAT (6E12.6)

This card is input for IW = 3/4 only.

PHI(I) Weighting function for neutron groups if IW = 3 or neutron and gamma groups for IW = 4.

CARDS NOS. 6 and 7 are input for MIX function only.

CARD NO. 6 FØRMAT (I5)

N Number of mixture(s).

CARD(s) NO. 7 FØRMAT (2I5/(I12,E12.5))

MM Mixture ID number.

M Number of material(s) in the mixture.

IMAT(1) ID number for the first material in the mixture.

DIMAT(1) Number density for the first material in the mixture.

IMAT(2)	ID number for the second material in the mixture.
DIMAT(2)	Number density for the second material in the mixture.
.	
.	
IMAT(M)	ID number for the m-th material in the mixture.
DSMAT(M)	Number density for the m-th material in the mixture.

Detailed Notes

(1) This program can be used for different functions in the same run. As an example add some materials and replace others and then collapse to lower number of groups. The only restriction is that the input library must be in ANISN card image format, so the output from function to another must be in ANISN card image format.

(2) The input to the collapse program is restricted to 171 neutron groups and 36 gamma groups. In other words, it is not allowed to start collapsing from other group structures.

(3) The program can be used to generate a small library with limited number of materials. The delete option can be used to keep the required material only.

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TABLE I
List of Materials in MACKLIB-IV

	ENDF/B MAT No.		ENDF/B MAT No.
Hydrogen	1269	Copper	1295
Helium	1270	Niobium	1189
Lithium-6	1271	Molybdenum	1287
Lithium-7	1272	Tantalum	1285
Beryllium	1289	Tungsten-182	1128
Boron-10	1273	Tungsten-183	1129
Boron-11	1160	Tungsten-184	1130
Carbon	1274	Tungsten-186	1131
Nitrogen	1275	Lead	1288
Oxygen	1276	Thorium-232	1296
Flourine	1277	Protactinium	1297
Sodium	1156	Uranium-233	1260
Magnesium	1280	Uranium-234	1043
Aluminum	1193	Uranium-235	1261
Silicon	1194	Uranium-236	1163
Chlorine	1149	Uranium-238	1262
Potassium	1150	Neptunium	1263
Calcium	1195	Plutonium-238	1050
Titanium	1286	Plutonium-239	1264
Vanadium	1196	Plutonium-240	1265
Chromium	1191	Plutonium-241	1266
Manganese	1197	Plutonium-242	1161
Iron	1192	Americium-241	1056
Cobalt	1199	Americium-243	1057
Nickel	1190		

TABLE II
 MACK-Activity Table
 (For each energy group, there are IHM entries
 arranged according to this table.)

Position	Content	
1	Neutron and gamma kerma factors	
2	Neutron kerma factor	
3	Gamma kerma factor	
4	Displacement cross section - A	
5	Displacement cross section - B	
6	Total hydrogen production cross section	
7	Total tritium production cross section	
8	Total helium production cross section	
9	Total cross section	
10	Elastic cross section	
11	Total inelastic cross section	
12	(n,2n) cross section	
13	(n,3n) cross section	
14	Total fission cross section	
15	(n,n't) cross section	
16	(n,n') continuum cross section	
17	(n, γ) cross section	
18	(n,p) cross section	
19	(n,D) cross section	
20	(n,t) cross section	
21	(n, ^3He) cross section	
22	(n, α) cross section	
23	Elastic scattering kerma factor	
24	(n,n') charged particles kerma factor	
25	Inelastic-level scattering kerma factor	
26	(n, charged particles) kerma factor	
27	(n,2n) kerma factor	
28	(n,3n) kerma factor	
29	Fission kerma factor	
30	Inelastic continuum kerma factor	
31	Radiative capture kerma factor	
32	Group mid-energy for neutron and gamma	
33	Group mid-energy for neutron only	
34	Group mid-energy for gamma only	
35	IHM	{ Positions 35-IHM are filled with cross sections for the MT reactions not given in the fixed positions 1-34.
.		
.		

TABLE III
Neutron 171 Energy Group Structure (eV)

Group	E(TOP)	Lethargy
1	0.17333E + 08	-0.55000E + 00
2	0.16487E + 08	-0.50000E + 00
3	0.15683E + 08	-0.45000E + 00
4	0.14918E + 08	-0.40000E + 00
5	0.14550E + 08	-0.37500E + 00
6	0.14191E + 08	-0.35000E + 00
7	0.13840E + 08	-0.32500E + 00
8	0.13499E + 08	-0.30000E + 00
9	0.12840E + 08	-0.25000E + 00
10	0.12214E + 08	-0.20000E + 00
11	0.11618E + 08	-0.15000E + 00
12	0.11052E + 08	-0.10000E + 00
13	0.10513E + 08	-0.50000E + 01
14	0.10000E + 08	0.0
15	0.95123E + 07	0.50000E - 01
16	0.90484E + 07	0.10000E + 00
17	0.86071E + 07	0.15000E + 00
18	0.81873E + 07	0.20000E + 00
19	0.77880E + 07	0.25000E + 00
20	0.74082E + 07	0.30000E + 00
21	0.70469E + 07	0.35000E + 00
22	0.67032E + 07	0.40000E + 00
23	0.65924E + 07	0.41667E + 00
24	0.63763E + 07	0.45000E + 00
25	0.60653E + 07	0.50000E + 00
26	0.57695E + 07	0.55000E + 00
27	0.54881E + 07	0.60000E + 00
28	0.52205E + 07	0.65000E + 00
29	0.49659E + 07	0.70000E + 00
30	0.47237E + 07	0.75000E + 00
31	0.44933E + 07	0.80000E + 00
32	0.40657E + 07	0.90000E + 00
33	0.36788E + 07	0.10000E + 01
34	0.33287E + 07	0.11000E + 01
35	0.31664E + 07	0.11500E + 01
36	0.30119E + 07	0.12000E + 01
37	0.28650E + 07	0.12500E + 01
38	0.27253E + 07	0.13000E + 01
39	0.25924E + 07	0.13500E + 01
40	0.24660E + 07	0.14000E + 01
41	0.23852E + 07	0.14333E + 01
42	0.23653E + 07	0.14417E + 01
43	0.23457E + 07	0.14500E + 01
44	0.23069E + 07	0.14667E + 01
45	0.22313E + 07	0.15000E + 01
46	0.21225E + 07	0.15500E + 01

TABLE III (Contd.)
Neutron 171 Energy Group Structure (eV)

Group	E(TOP)	Lethargy
47	0.20190E + 07	0.16000E + 01
48	0.19205E + 07	0.16500E + 01
49	0.18268E + 07	0.17000E + 01
50	0.17377E + 07	0.17500E + 01
51	0.16530E + 07	0.18000E + 01
52	0.15724E + 07	0.18500E + 01
53	0.14957E + 07	0.19000E + 01
54	0.14227E + 07	0.19500E + 01
55	0.13534E + 07	0.20000E + 01
56	0.12873E + 07	0.20500E + 01
57	0.12246E + 07	0.21000E + 01
58	0.11648E + 07	0.21500E + 01
59	0.11080E + 07	0.22000E + 01
60	0.10026E + 07	0.23000E + 01
61	0.96164E + 06	0.23417E + 01
62	0.90718E + 06	0.24000E + 01
63	0.86294E + 06	0.24500E + 01
64	0.82085E + 06	0.25000E + 01
65	0.78082E + 06	0.25500E + 01
66	0.74274E + 06	0.26000E + 01
67	0.70651E + 06	0.26500E + 01
68	0.67206E + 06	0.27000E + 01
69	0.63928E + 06	0.27500E + 01
70	0.60810E + 06	0.28000E + 01
71	0.57844E + 06	0.28500E + 01
72	0.55023E + 06	0.29000E + 01
73	0.52340E + 06	0.29500E + 01
74	0.49787E + 06	0.30000E + 01
75	0.45049E + 06	0.31000E + 01
76	0.40762E + 06	0.32000E + 01
77	0.38774E + 06	0.32500E + 01
78	0.36883E + 06	0.33000E + 01
79	0.33373E + 06	0.34000E + 01
80	0.30197E + 06	0.35000E + 01
81	0.29850E + 06	0.35116E + 01
82	0.29720E + 06	0.35159E + 01
83	0.29452E + 06	0.35250E + 01
84	0.28725E + 06	0.35500E + 01
85	0.27324E + 06	0.36000E + 01
86	0.24724E + 06	0.37000E + 01
87	0.23518E + 06	0.37500E + 01
88	0.22371E + 06	0.38000E + 01
89	0.21280E + 06	0.38500E + 01
90	0.20242E + 06	0.39000E + 01
91	0.19255E + 06	0.39500E + 01
92	0.18316E + 06	0.40000E + 01

TABLE III (Contd.)

Neutron 171 Energy Group Structure (eV)

Group	E(TOP)	Lethargy
93	0.17422E + 06	0.40500E + 01
94	0.16573E + 06	0.41000E + 01
95	0.15764E + 06	0.41500E + 01
96	0.14996E + 06	0.42000E + 01
97	0.14264E + 06	0.42500E + 01
98	0.13569E + 06	0.43000E + 01
99	0.12907E + 06	0.43500E + 01
100	0.12277E + 06	0.44000E + 01
101	0.11679E + 06	0.44500E + 01
102	0.11109E + 06	0.45000E + 01
103	0.98037E + 05	0.46250E + 01
104	0.86517E + 05	0.47500E + 01
105	0.82500E + 05	0.47975E + 01
106	0.79500E + 05	0.48346E + 01
107	0.72000E + 05	0.49337E + 01
108	0.67379E + 05	0.50000E + 01
109	0.56562E + 05	0.51750E + 01
110	0.52475E + 05	0.52500E + 01
111	0.46309E + 05	0.53750E + 01
112	0.40868E + 05	0.55000E + 01
113	0.34307E + 05	0.56750E + 01
114	0.31828E + 05	0.57500E + 01
115	0.28500E + 05	0.58604E + 01
116	0.27000E + 05	0.59145E + 01
117	0.26058E + 05	0.59500E + 01
118	0.24788E + 05	0.60000E + 01
119	0.24176E + 05	0.60250E + 01
120	0.23579E + 05	0.60500E + 01
121	0.21875E + 05	0.61250E + 01
122	0.19305E + 05	0.62500E + 01
123	0.15034E + 05	0.65000E + 01
124	0.11709E + 05	0.67500E + 01
125	0.91188E + 04	0.70000E + 01
126	0.71017E + 04	0.72500E + 01
127	0.55308E + 04	0.75000E + 01
128	0.43074E + 04	0.77500E + 01
129	0.37074E + 04	0.79000E + 01
130	0.33546E + 04	0.80000E + 01
131	0.30354E + 04	0.81000E + 01
132	0.27465E + 04	0.82000E + 01
133	0.26126E + 04	0.82500E + 01
134	0.24852E + 04	0.83000E + 01
135	0.22487E + 04	0.84000E + 01
136	0.20347E + 04	0.85000E + 01
137	0.15846E + 04	0.87500E + 01
138	0.12341E + 04	0.90000E + 01

TABLE III (Contd.)
Neutron 171 Energy Group Structure (eV)

Group	E(TOP)	Lethargy
139	0.96112E + 03	0.92500E + 01
140	0.74852E + 03	0.95000E + 01
141	0.58295E + 03	0.97500E + 01
142	0.45400E + 03	0.10000E + 02
143	0.35358E + 03	0.10250E + 02
144	0.27536E + 03	0.10500E + 02
145	0.21445E + 03	0.10750E + 02
146	0.16702E + 03	0.11000E + 02
147	0.13007E + 03	0.11250E + 02
148	0.10130E + 03	0.11500E + 02
149	0.78893E + 02	0.11750E + 02
150	0.61442E + 02	0.12000E + 02
151	0.47851E + 02	0.12250E + 02
152	0.37267E + 02	0.12500E + 02
153	0.29203E + 02	0.12750E + 02
154	0.22603E + 02	0.13000E + 02
155	0.17603E + 02	0.13250E + 02
156	0.13710E + 02	0.13500E + 02
157	0.10677E + 02	0.13750E + 02
158	0.83153E + 01	0.14000E + 02
159	0.64760E + 01	0.14250E + 02
160	0.50435E + 01	0.14500E + 02
161	0.39279E + 01	0.14750E + 02
162	0.30590E + 01	0.15000E + 02
163	0.23824E + 01	0.15250E + 02
164	0.18554E + 01	0.15500E + 02
165	0.14450E + 01	0.15750E + 02
166	0.11254E + 01	0.16000E + 02
167	0.87642E + 00	0.16250E + 02
168	0.68256E + 00	0.16500E + 02
169	0.53158E + 00	0.16750E + 02
170	0.41399E + 00	0.17000E + 02
171	0.10000E - 00	
172	0.10000E - 04	

TABLE IV
Gamma 36 Energy Group Structure (MeV)

Group	E(TOP)	Group	E(TOP)
1	14.0	19	1.33
2	12.0	20	1.0
3	10.0	21	0.80
4	8.0	22	0.70
5	7.5	23	0.60
6	7.0	24	0.512
7	6.5	25	0.510
8	6.0	26	0.45
9	5.5	27	0.40
10	5.0	28	0.30
11	4.5	29	0.20
12	4.0	30	0.15
13	3.5	31	0.10
14	3.0	32	0.075
15	2.5	33	0.060
16	2.0	34	0.045
17	1.66	35	0.030
18	1.50	36	0.020
			0.010

TABLE V

Displacement Energy (E_d) Assumed in
Generating the Displacement Cross
Sections Given in Position 4
of MACKLIB-IV

Material	E_d (eV)
Aluminum	25
Vanadium	40
Chromium	40
Iron	40
Nickel	40
Copper	30
Niobium	60
Molybdenum	60
Tantalum	90
Tungsten	90
Lead	25

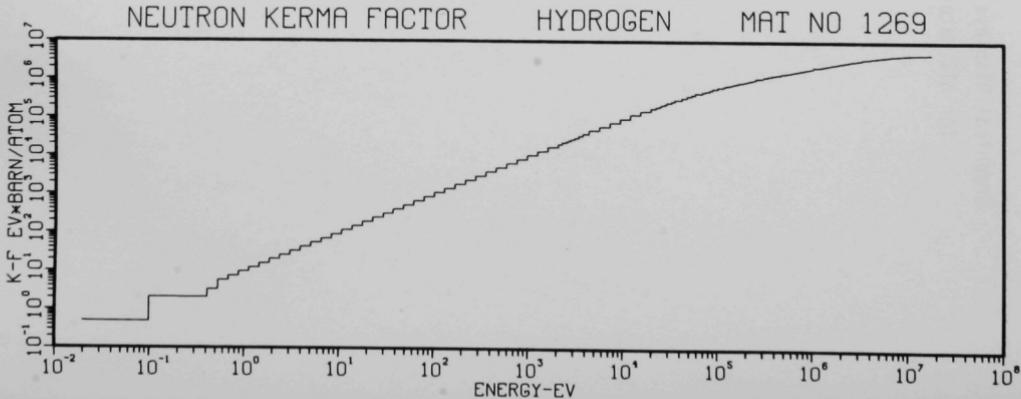
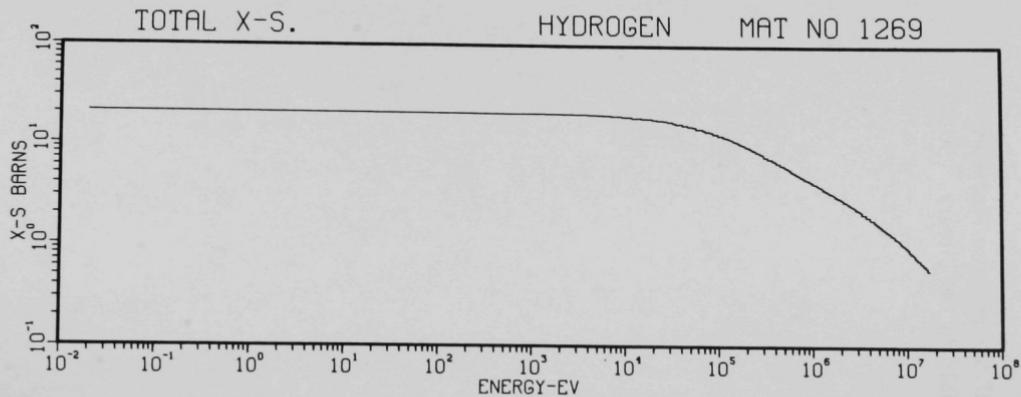
TABLE VI
 Fission Energy Used for
 Neutron Kerma Factor Calculation

	Fission Fragments Energy	Delayed Beta Energy	Delayed Gamma Energy
^{232}Th	162.10	8.23	8.01
^{233}U	168.68	5.13	4.99
^{235}U	169.58	6.43	6.26
^{238}U	170.03	8.25	8.04
^{239}Pu	175.90	5.30	5.16
^{238}Pu	176.30	5.20	5.00
^{240}Pu	175.80	6.10	6.00
^{242}Pu	175.20	7.40	7.20
^{241}Au	179.50	5.30	5.20
^{243}Au	179.00	6.30	6.10
^{241}Pu	175.53	6.51	6.33
^{233}Pa	165.70	6.90	6.70
^{234}U	169.40	5.80	5.60
^{235}U	168.90	7.00	6.80
^{237}Np	172.60	5.80	8.00

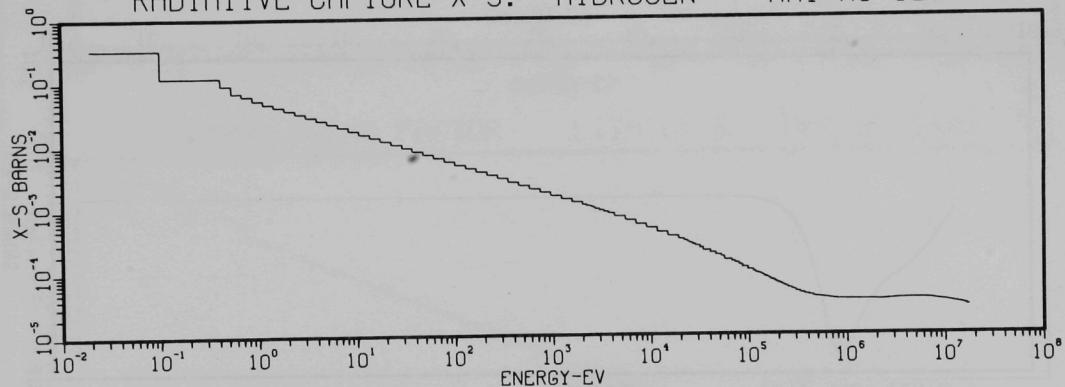
APPENDIX A

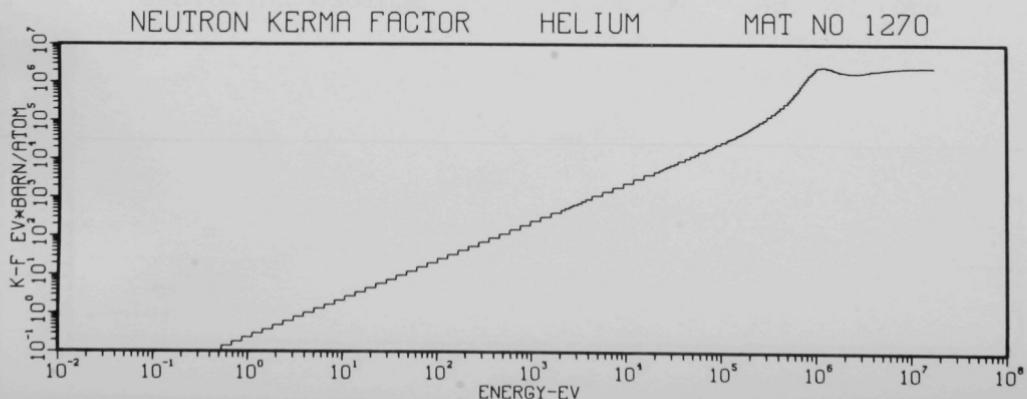
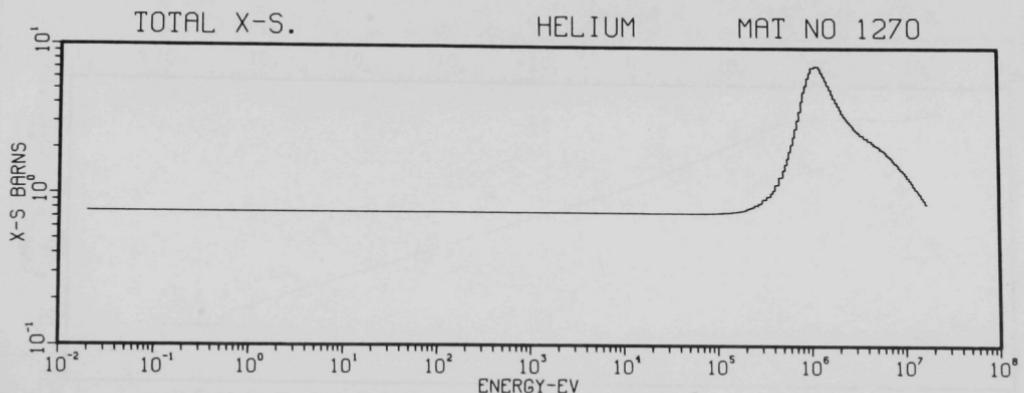
Graphical Displays of Six Response Functions for All Materials in the Library

Z-V



RADIATIVE CAPTURE X-S. HYDROGEN MAT NO 1269

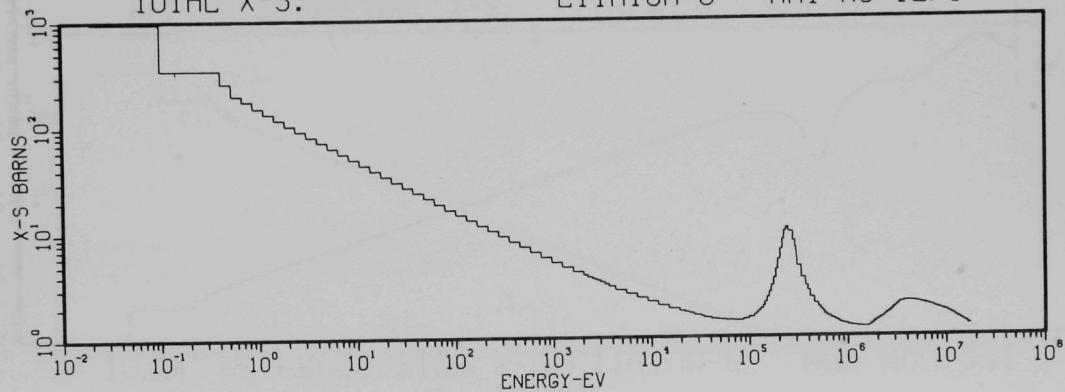




L-A

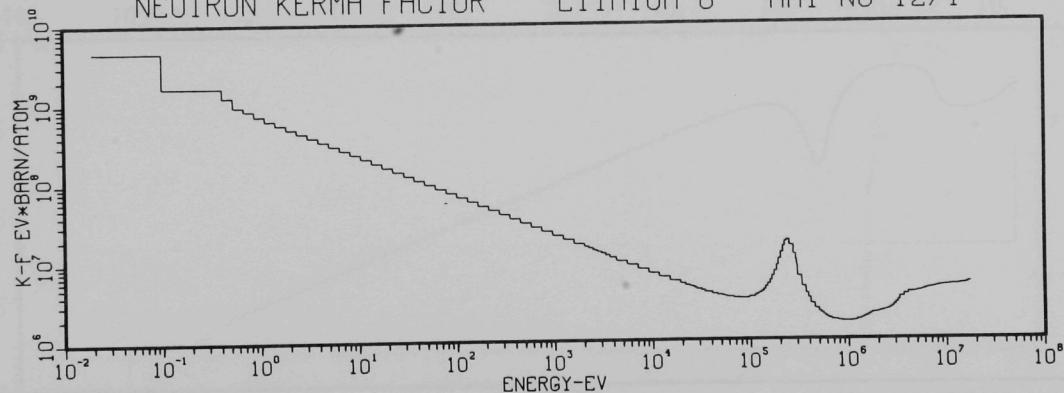
TOTAL X-S.

LITHIUM-6 MAT NO 1271

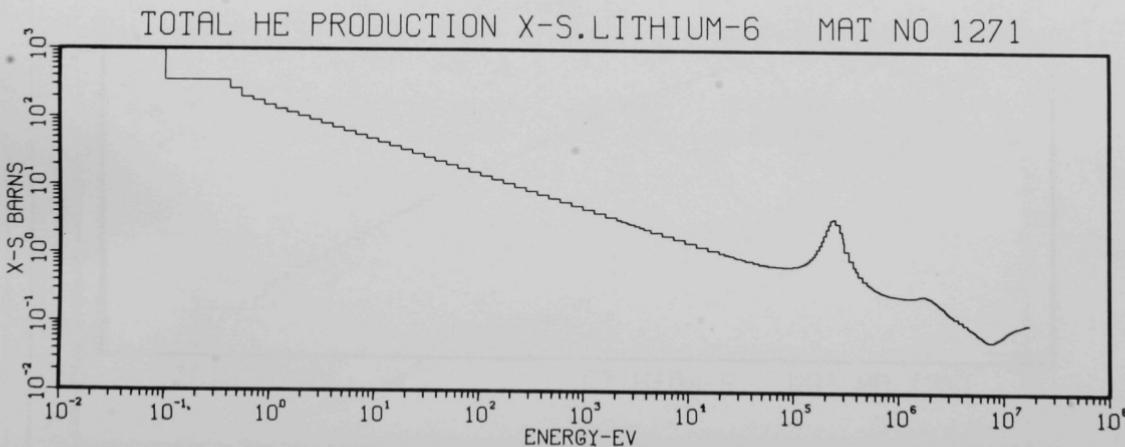
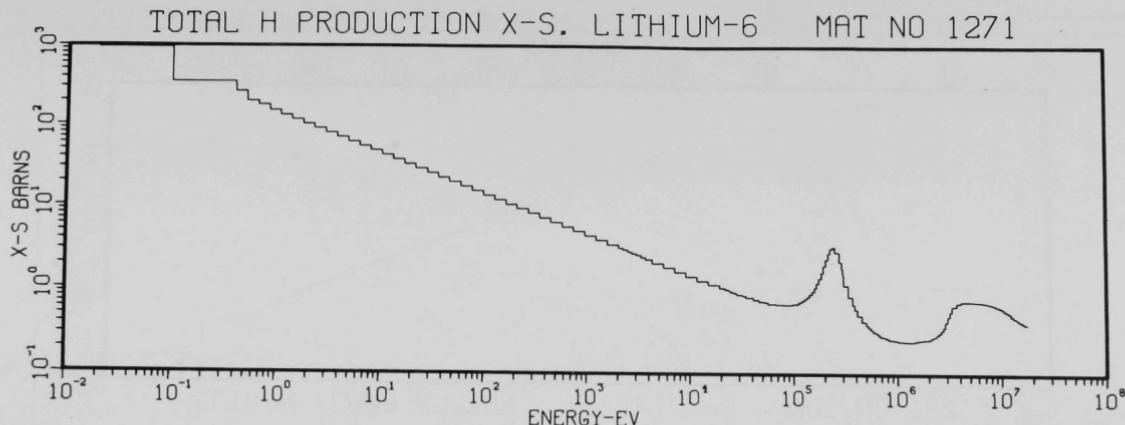


NEUTRON KERMA FACTOR

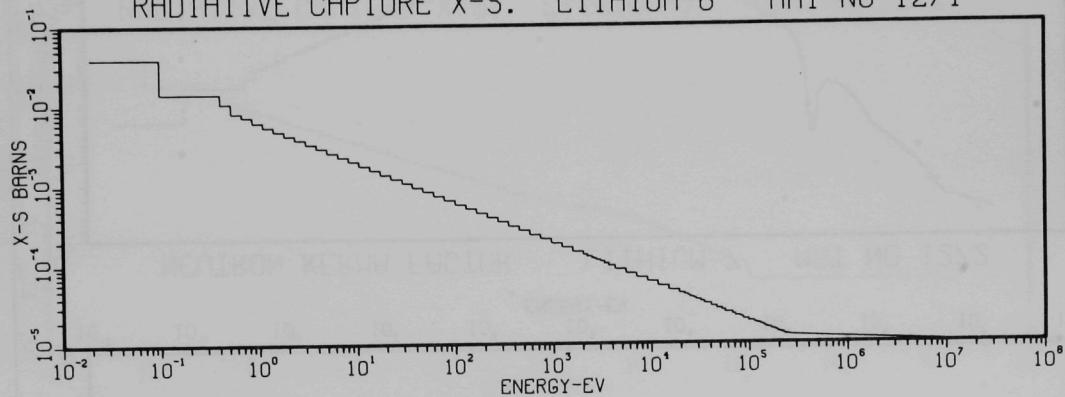
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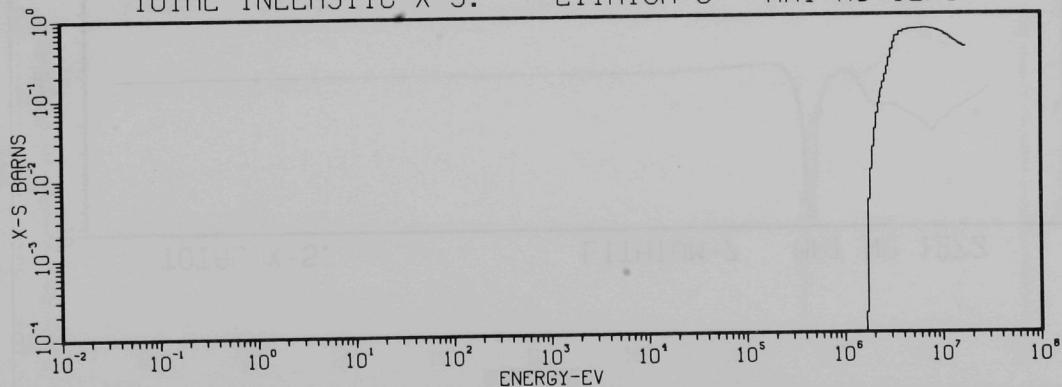
g-A



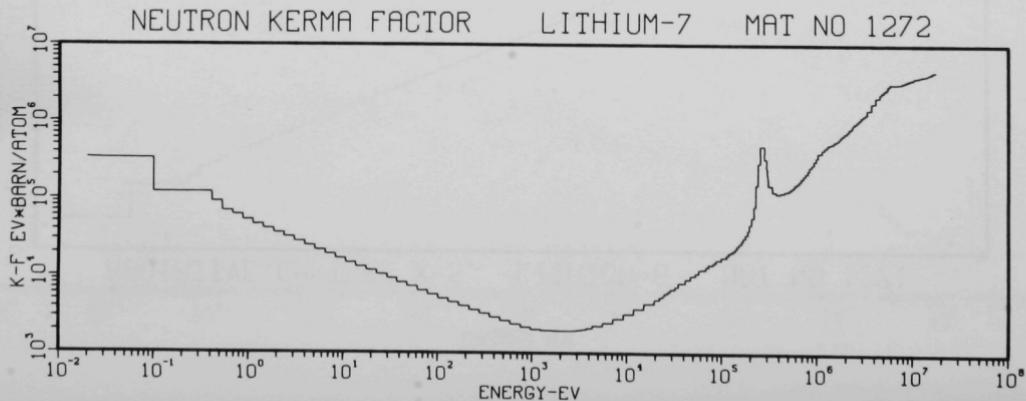
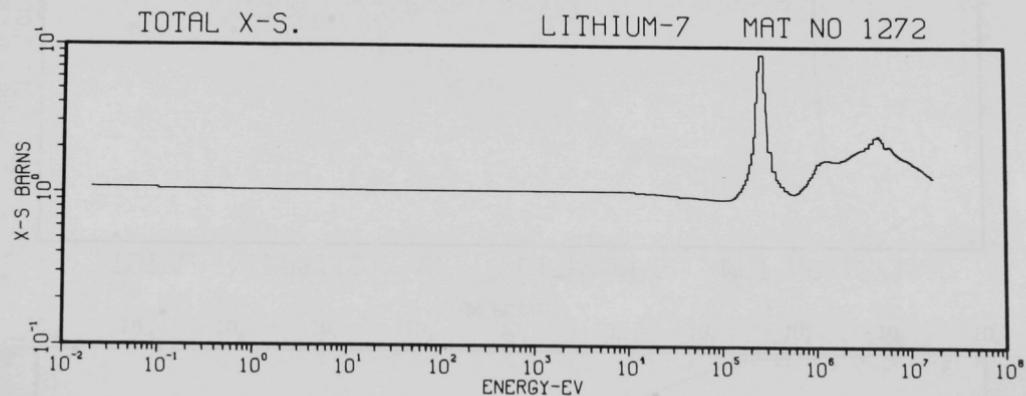
RADIATIVE CAPTURE X-S. LITHIUM-6 MAT NO 1271



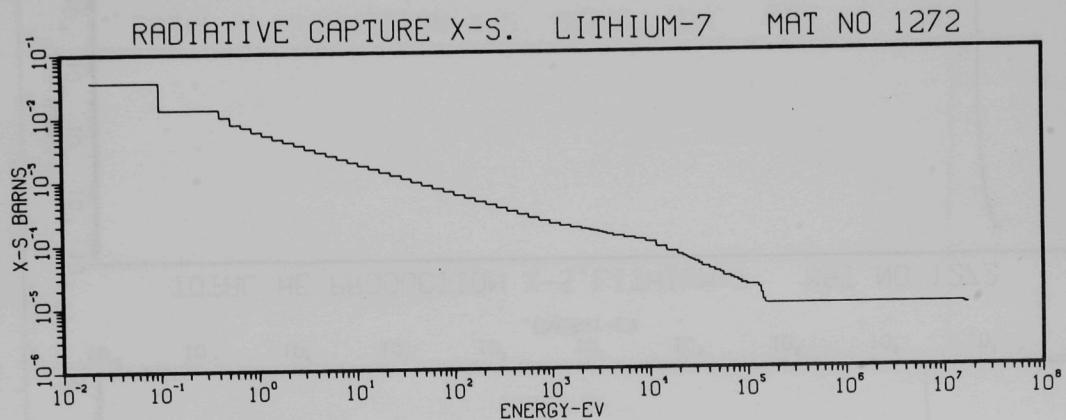
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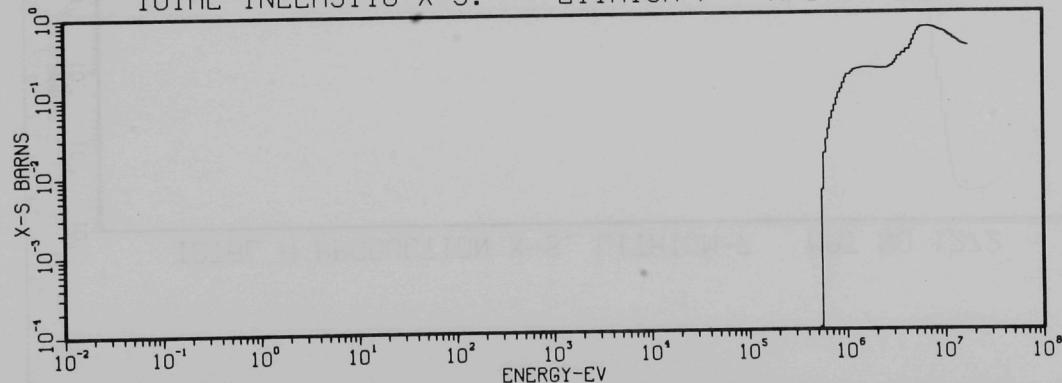
8-V



6-V

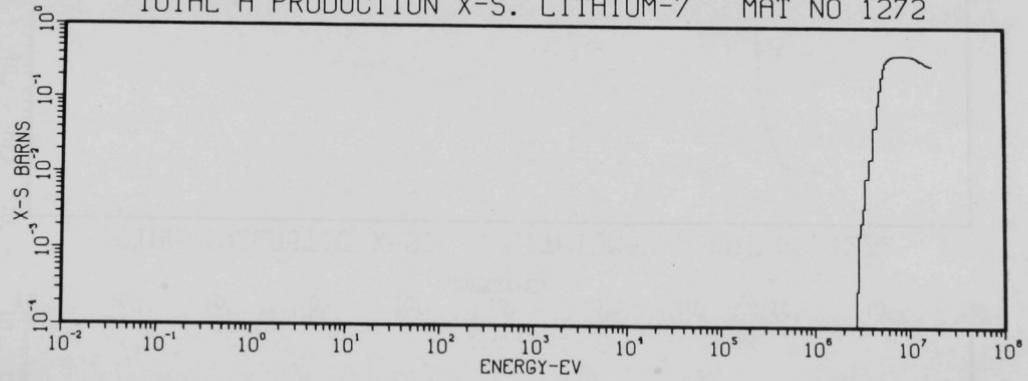


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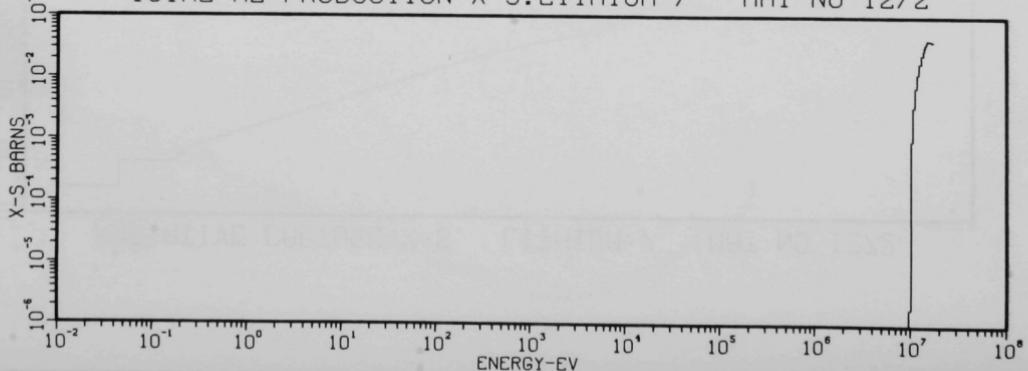


OL-A

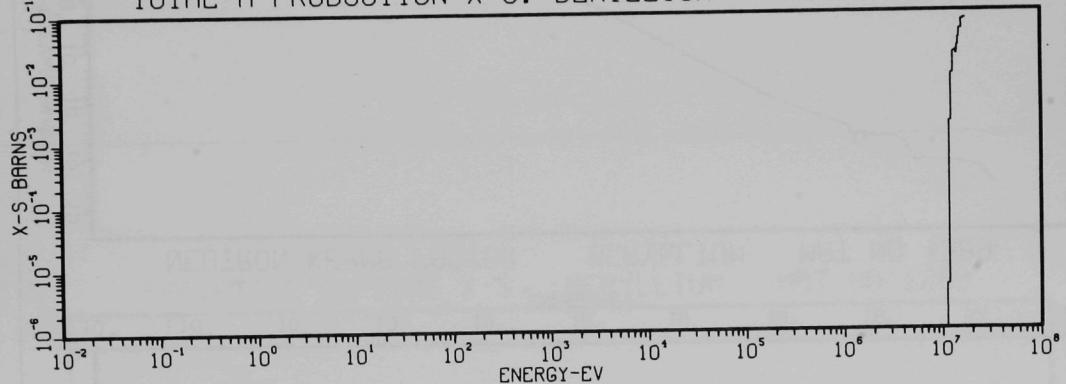
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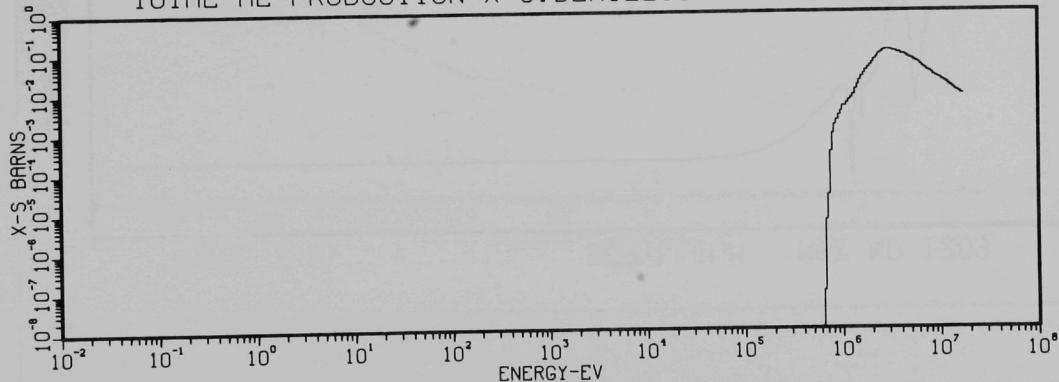
TOTAL HE PRODUCTION X-S.LITHIUM-7 MAT NO 1272



TOTAL H PRODUCTION X-S. BERYLLIUM MAT NO 1289

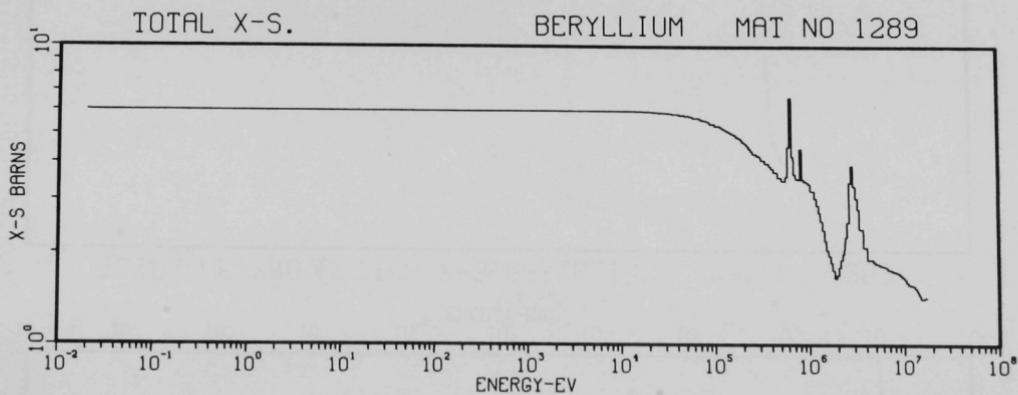


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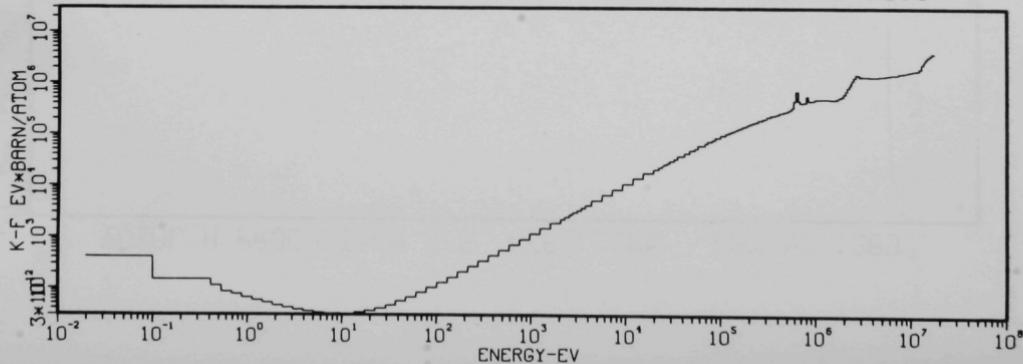


111-V

A-12

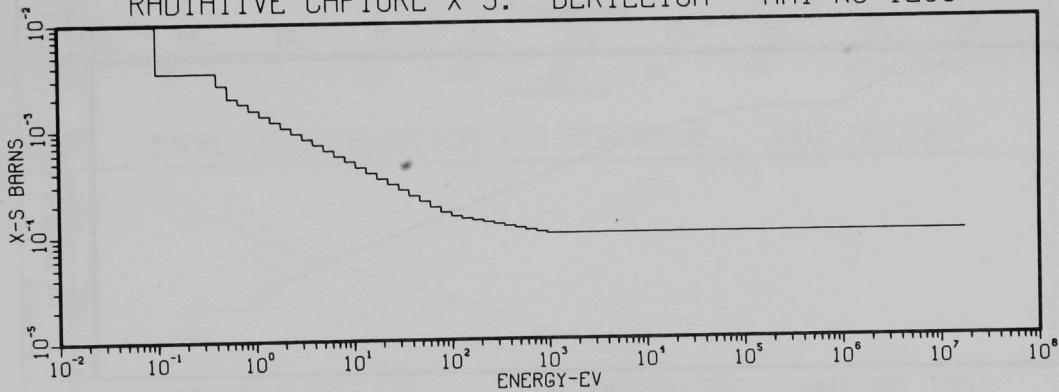


NEUTRON KERMA FACTOR BERYLLIUM MAT NO 1289

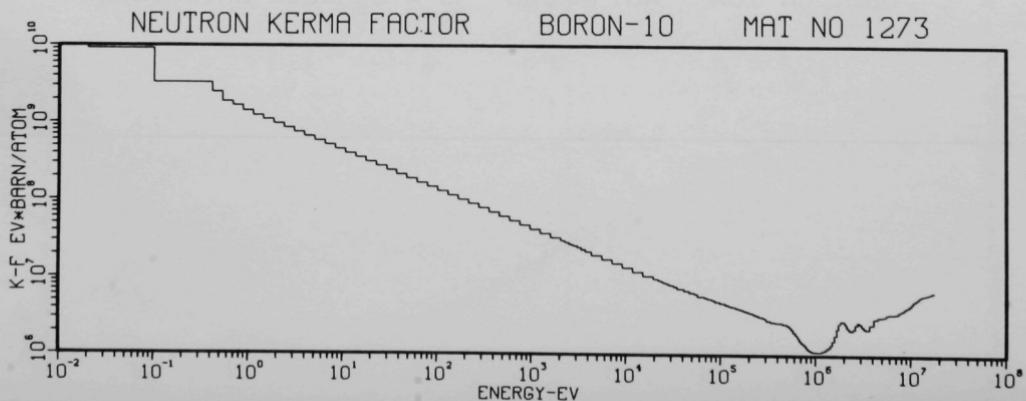
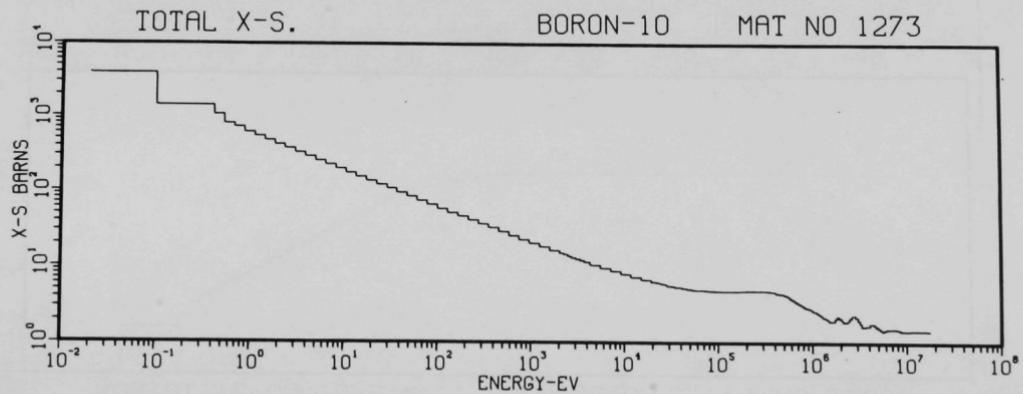


E-1-A

RADIATIVE CAPTURE X-S. BERYLLIUM MAT NO 1289

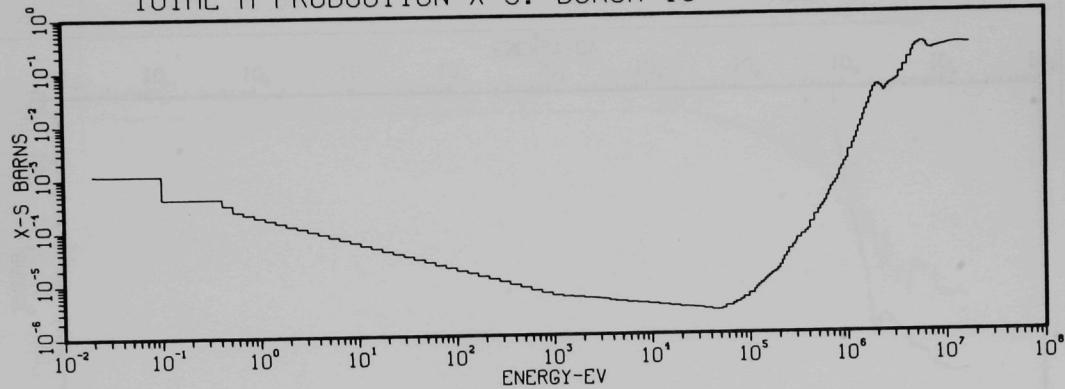


V1-A



TOTAL H PRODUCTION X-S. BORON-10

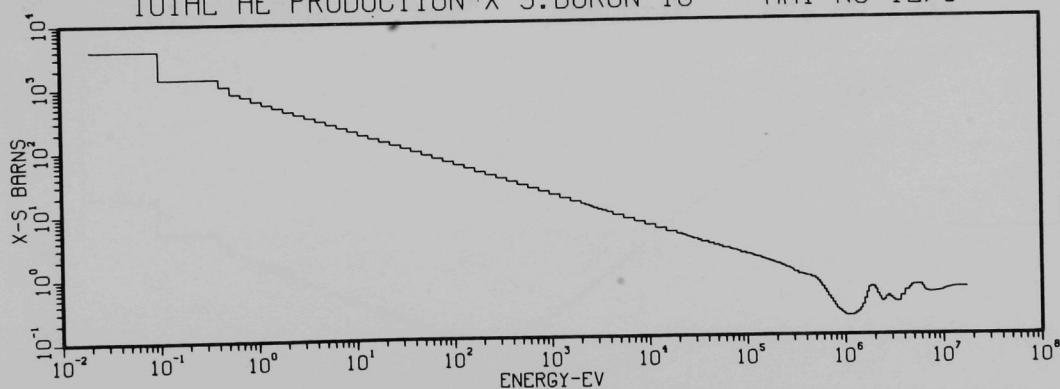
MAT NO 1273



A-15

TOTAL HE PRODUCTION X-S.BORON-10

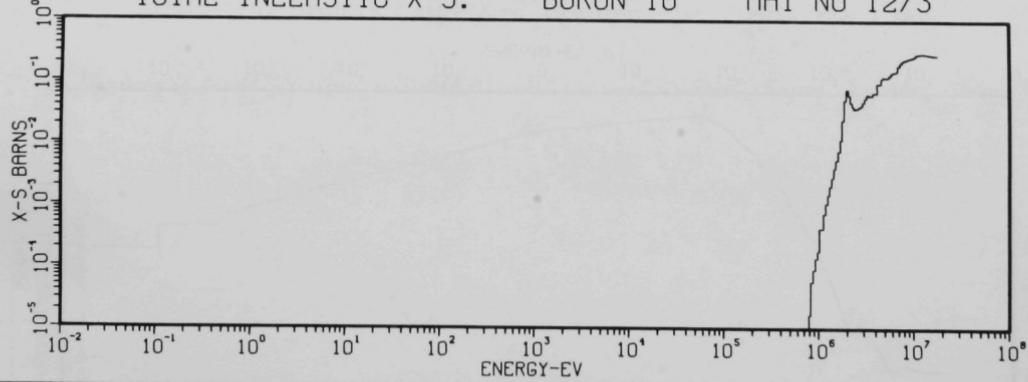
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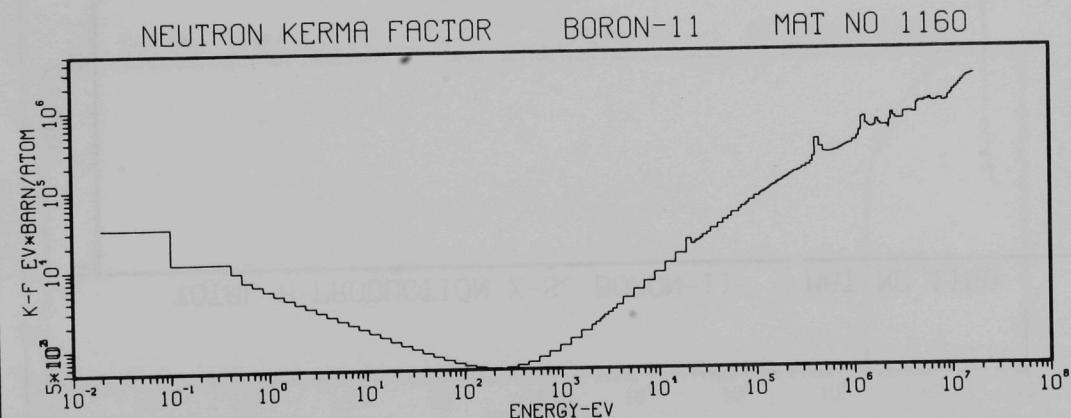
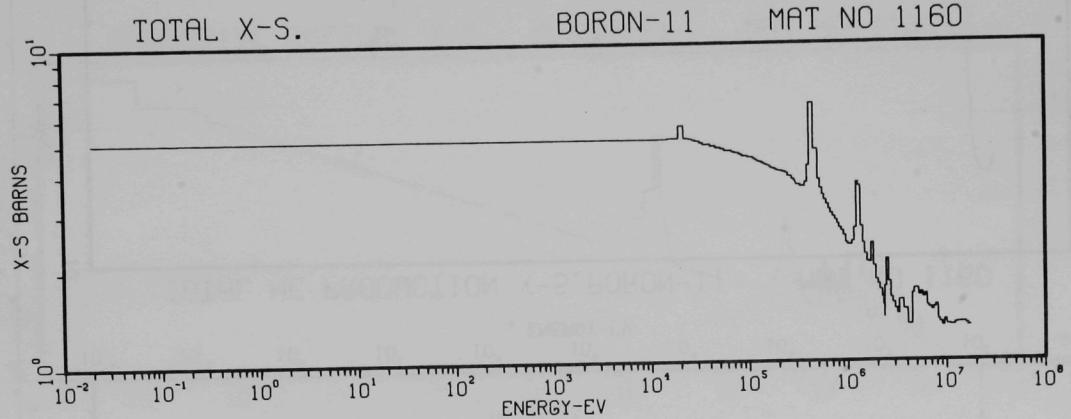


TOTAL INELASTIC X-S.

BORON-10

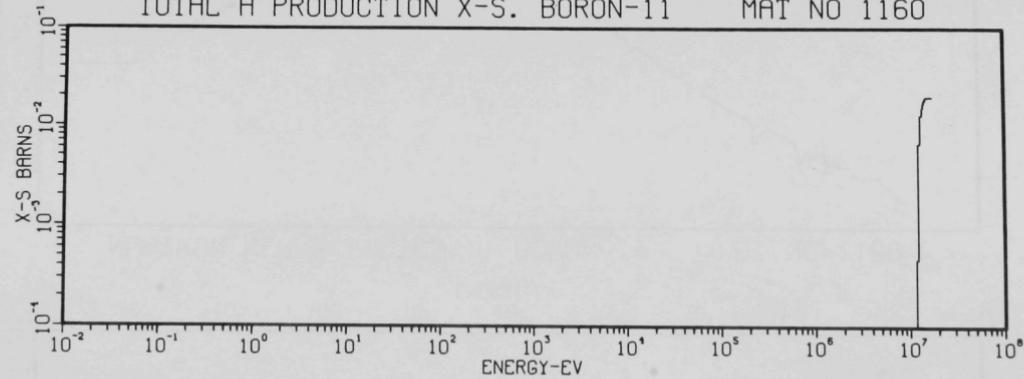
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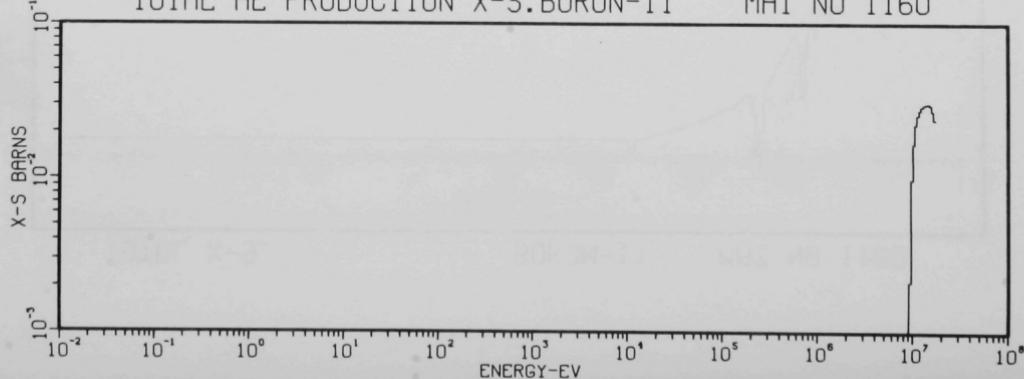


81-V

TOTAL H PRODUCTION X-S. BORON-11 MAT NO 1160

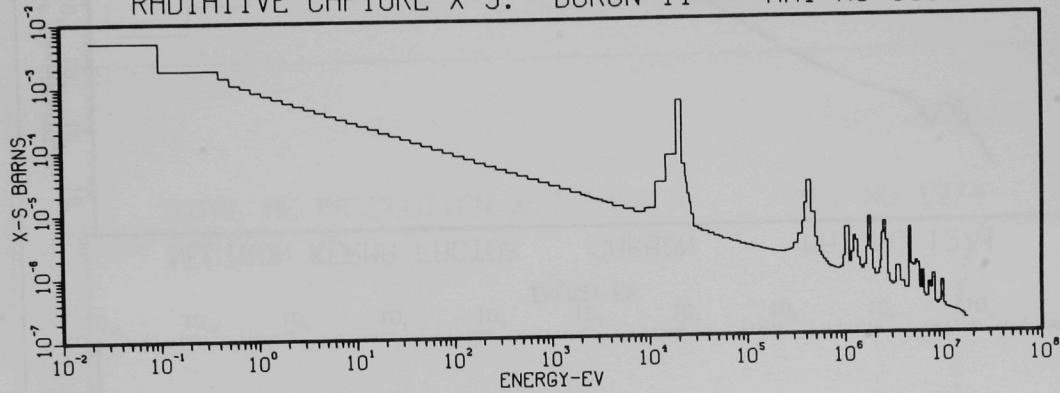


TOTAL HE PRODUCTION X-S.BORON-11 MAT NO 1160

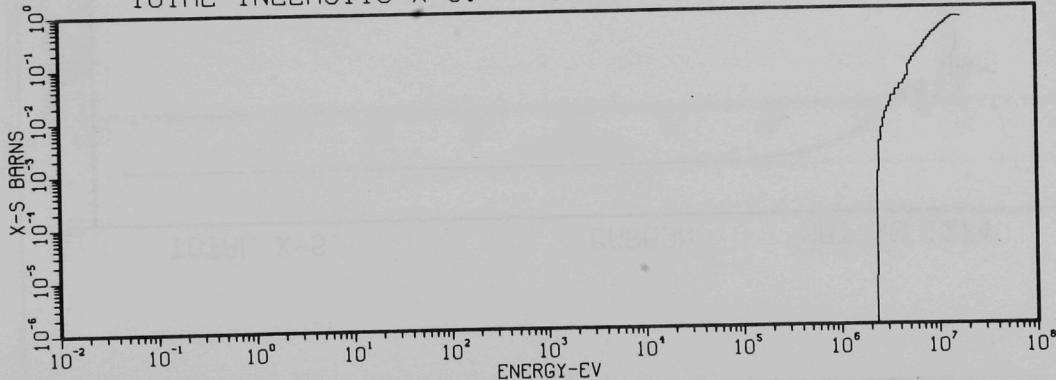


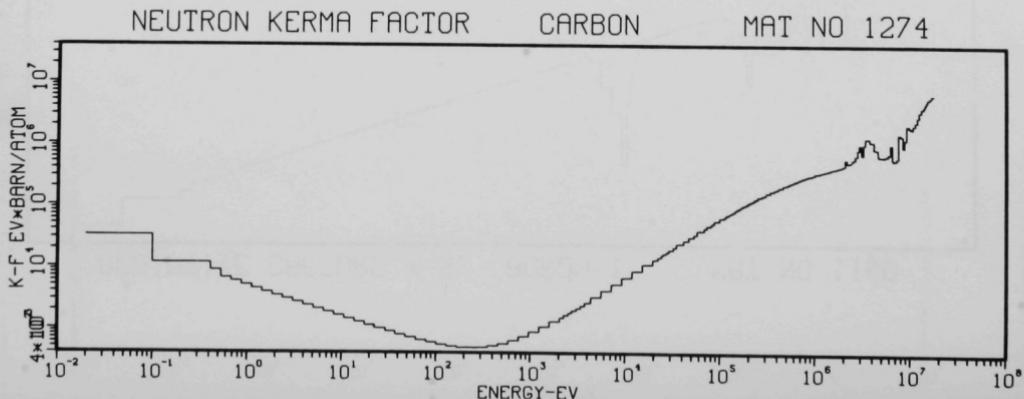
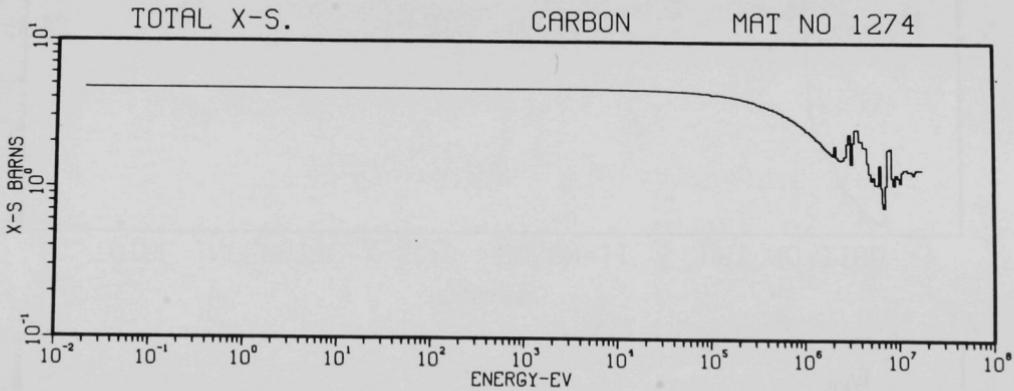
61-A

RADIATIVE CAPTURE X-S. BORON-11 MAT NO 1160

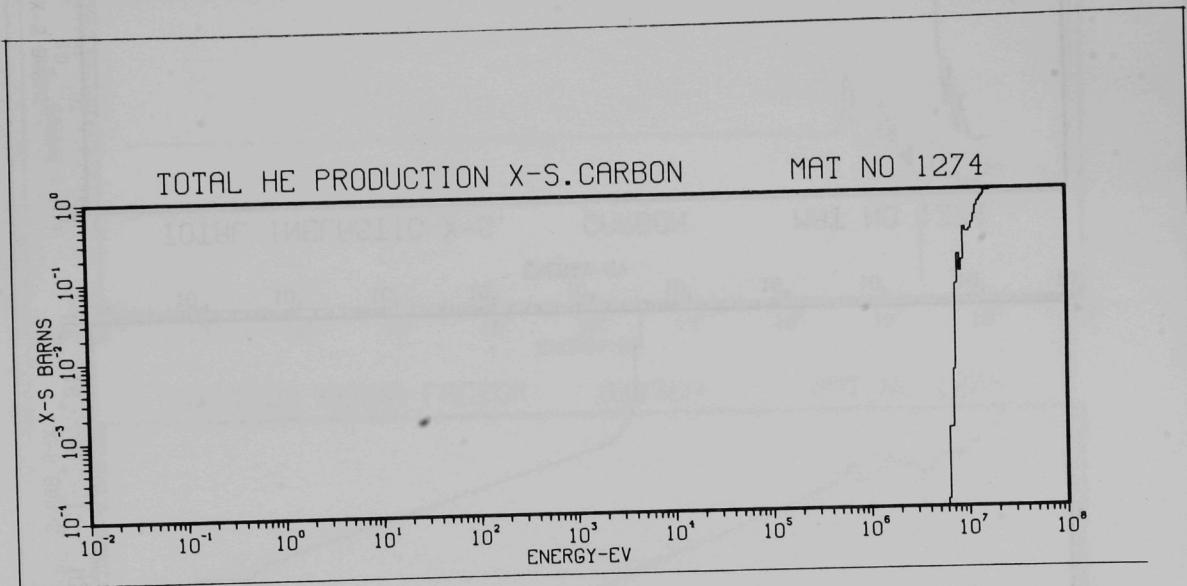


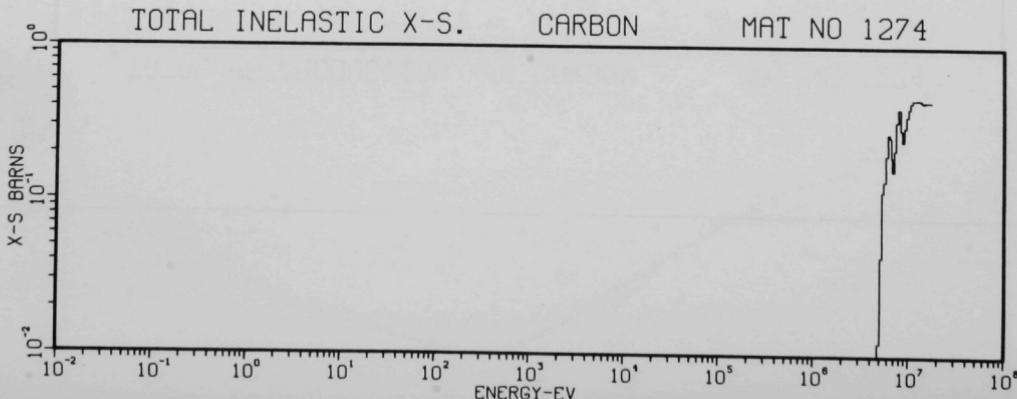
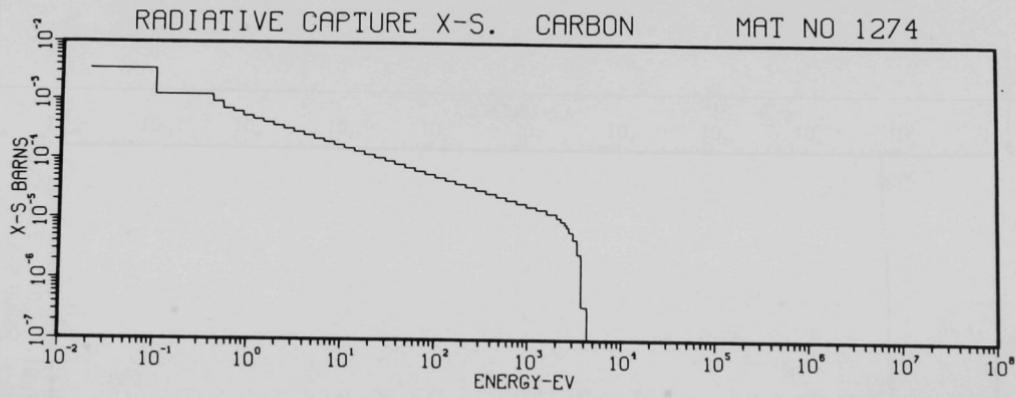
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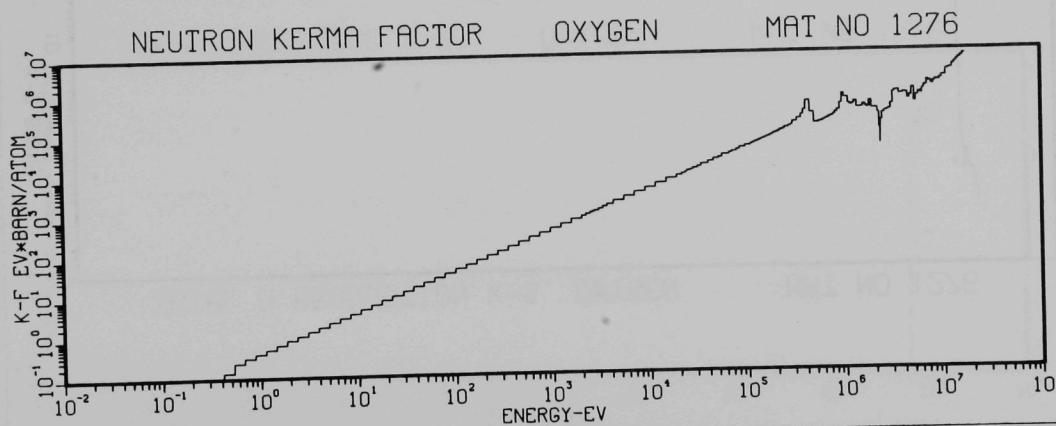
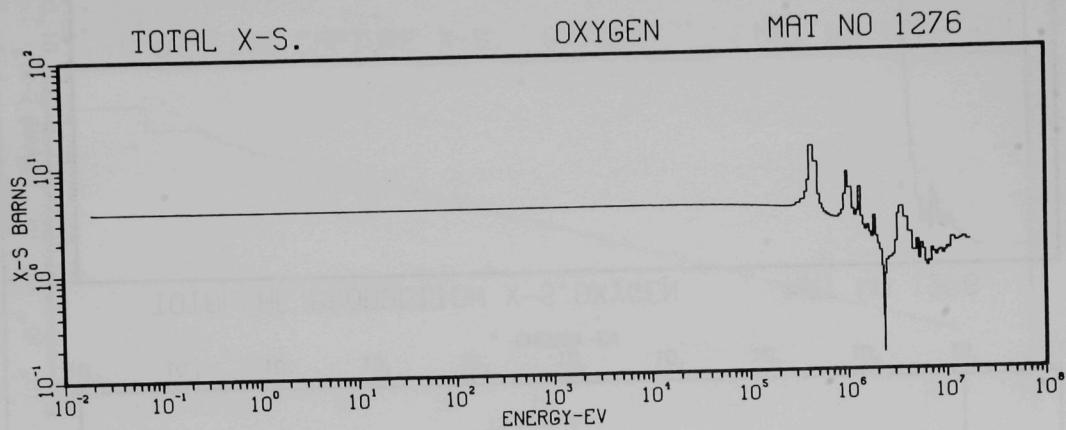


A-271



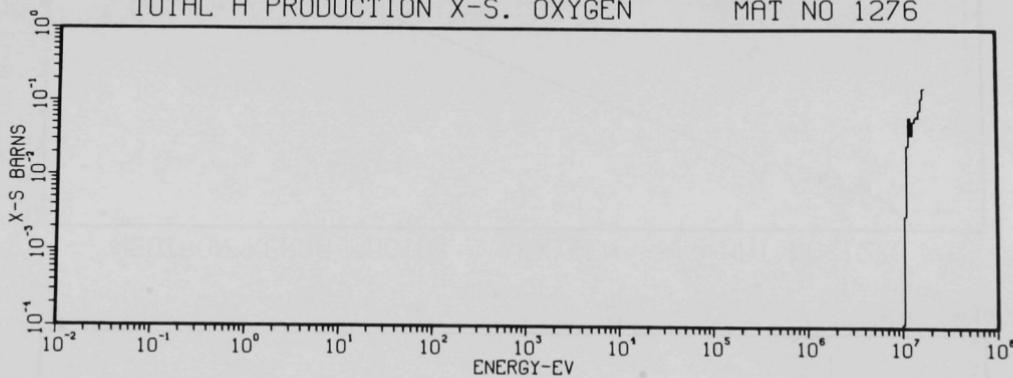


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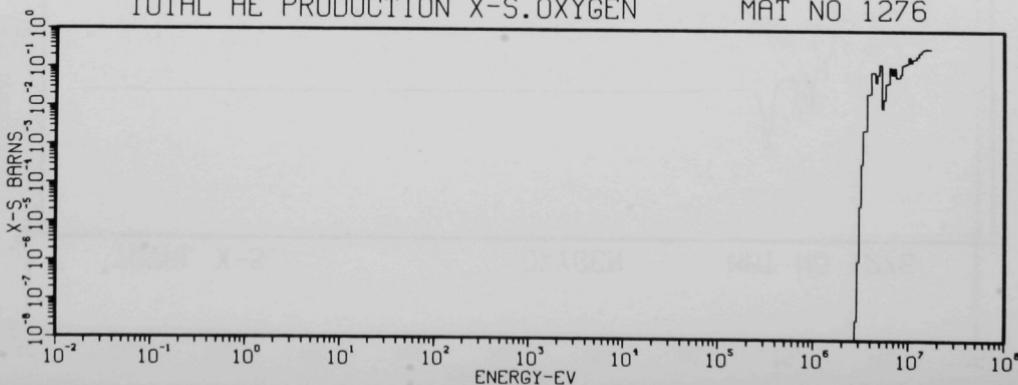
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MAT NO 1276



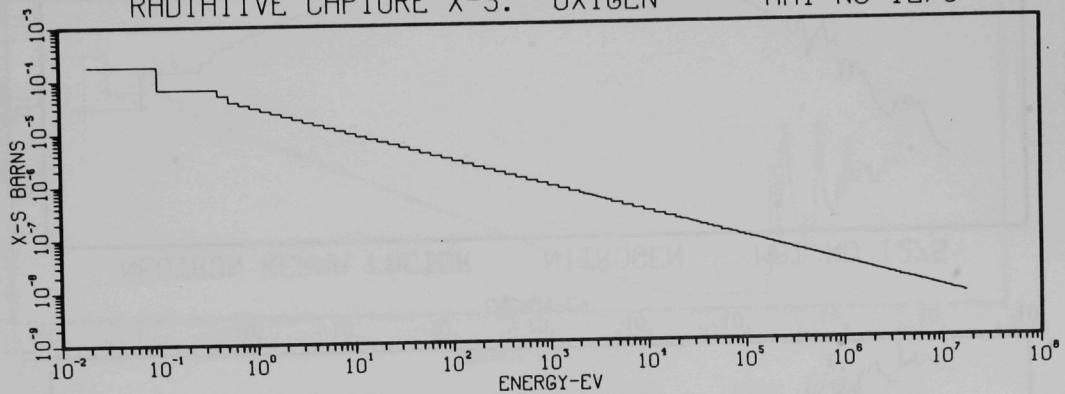
TOTAL HE PRODUCTION X-S.OXYGEN

MAT NO 1276



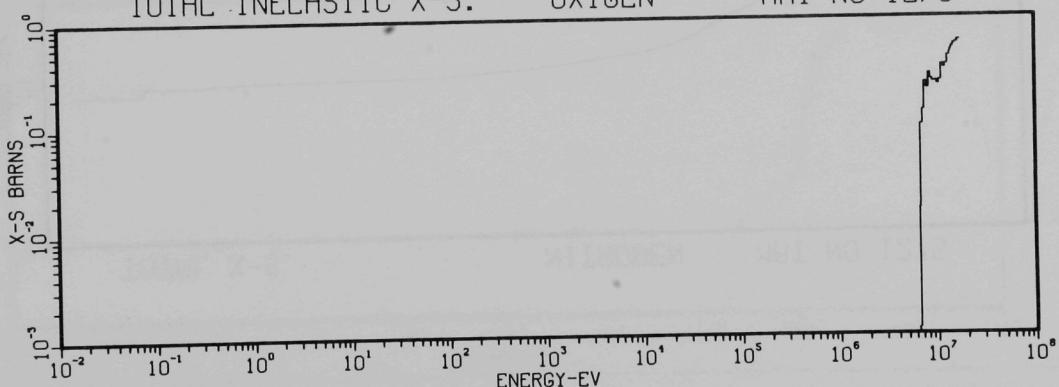
RADIATIVE CAPTURE X-S. OXYGEN

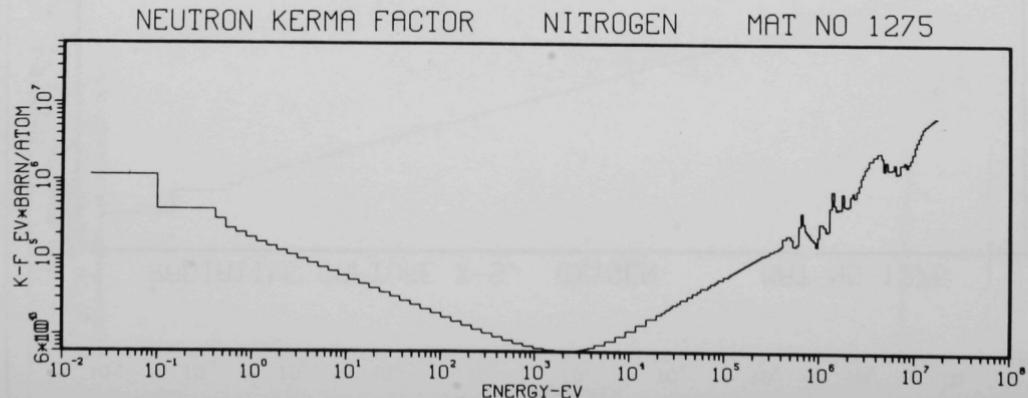
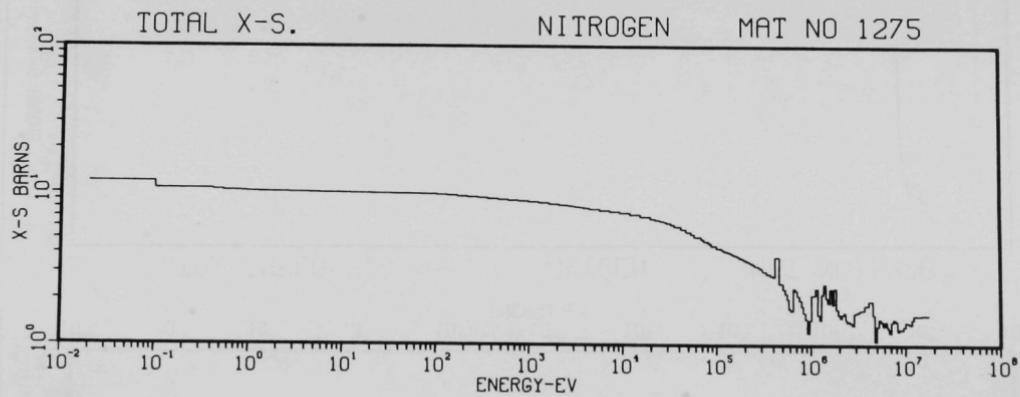
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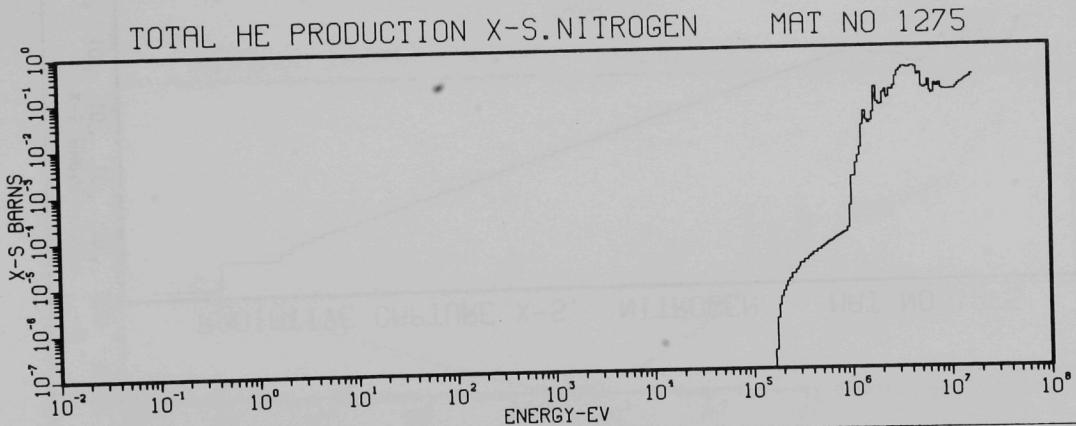
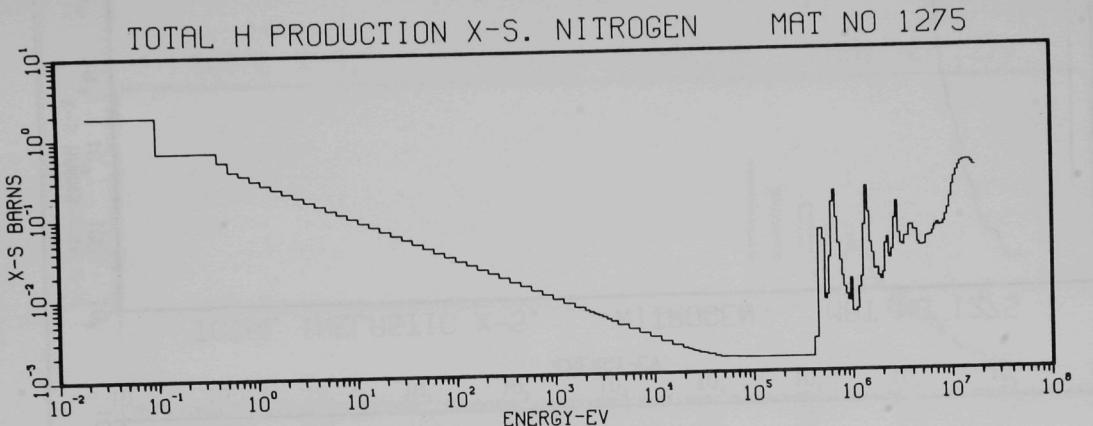


TOTAL INELASTIC X-S. OXYGEN

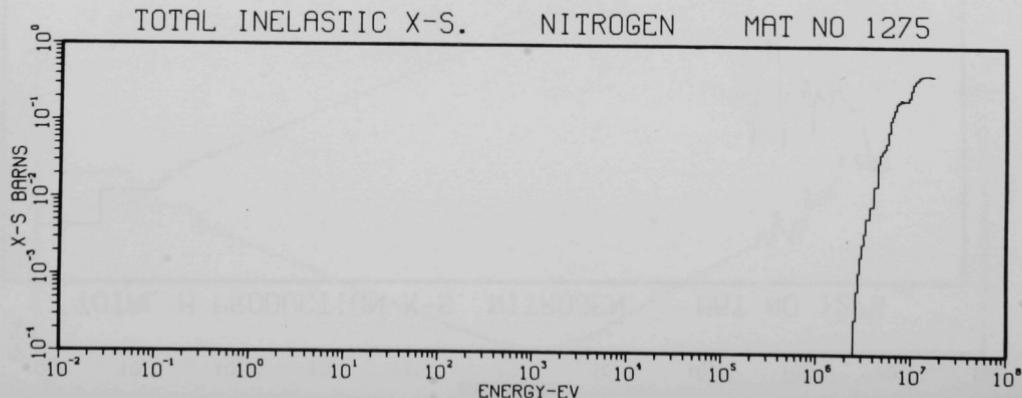
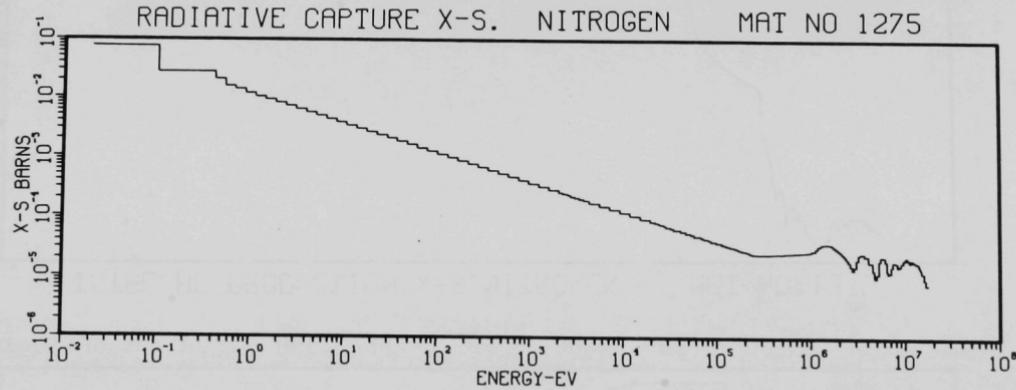
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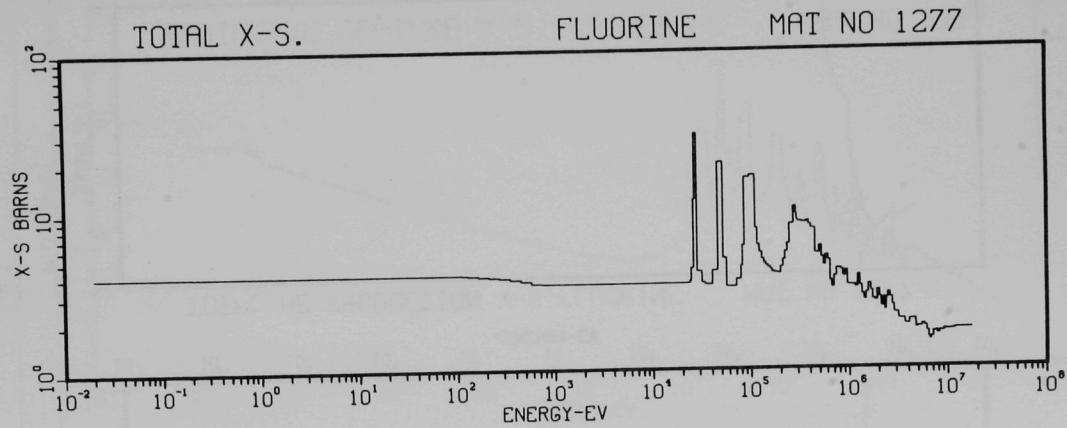




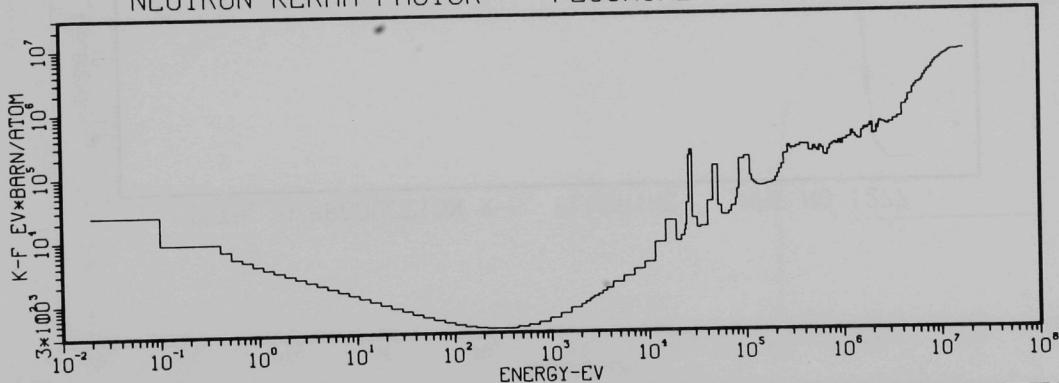
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A-29

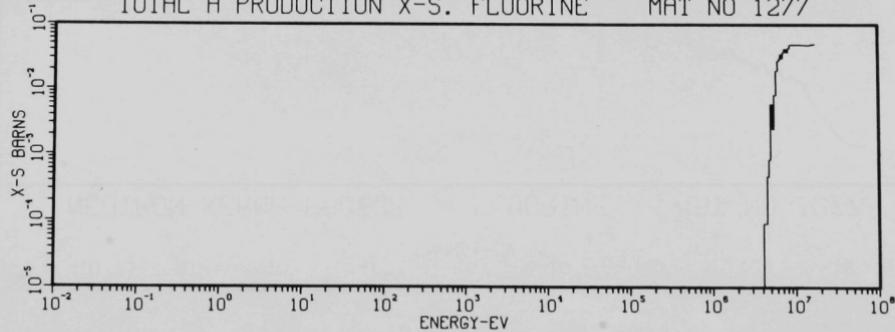


NEUTRON KERMA FACTOR FLUORINE MAT NO 1277

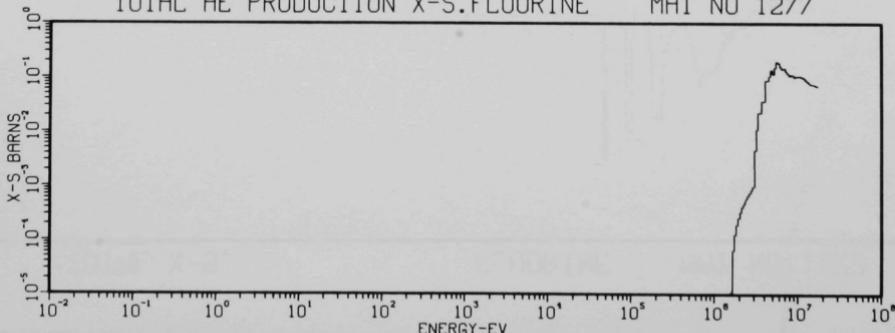


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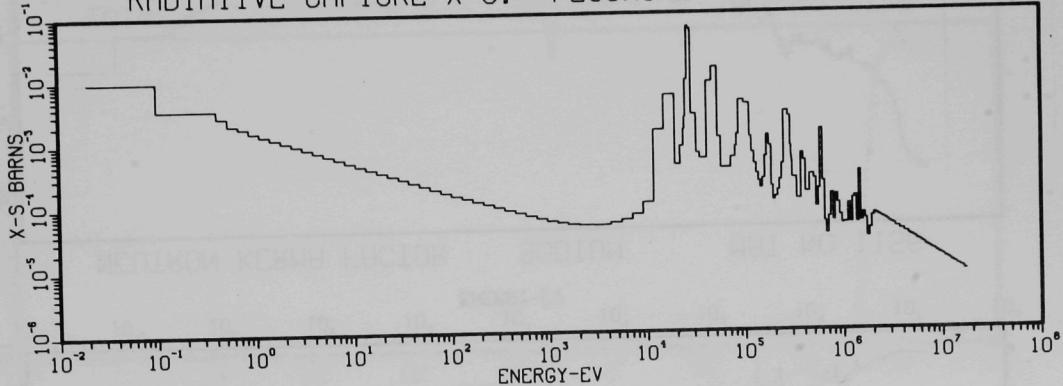
TOTAL H PRODUCTION X-S. FLUORINE MAT NO 1277



TOTAL HE PRODUCTION X-S. FLUORINE MAT NO 1277

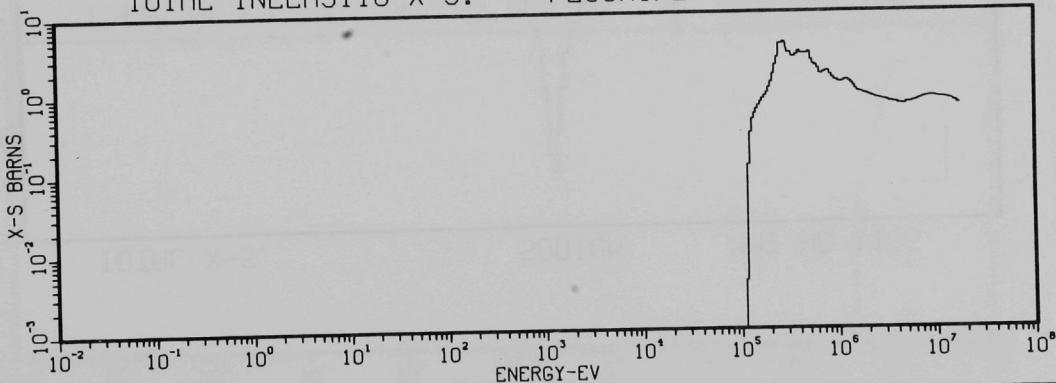


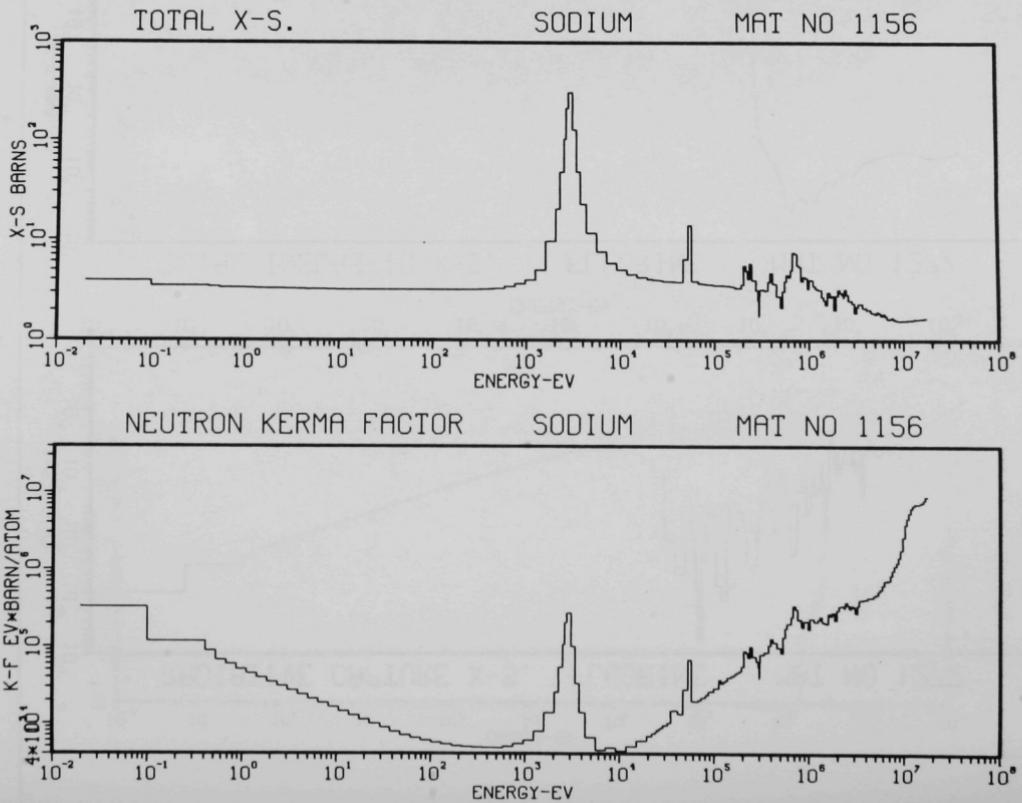
RADIATIVE CAPTURE X-S. FLUORINE MAT NO 1277



A-31

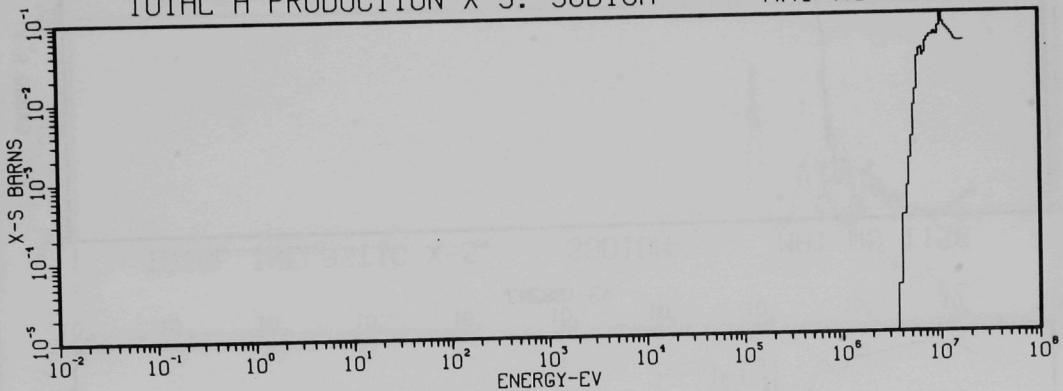
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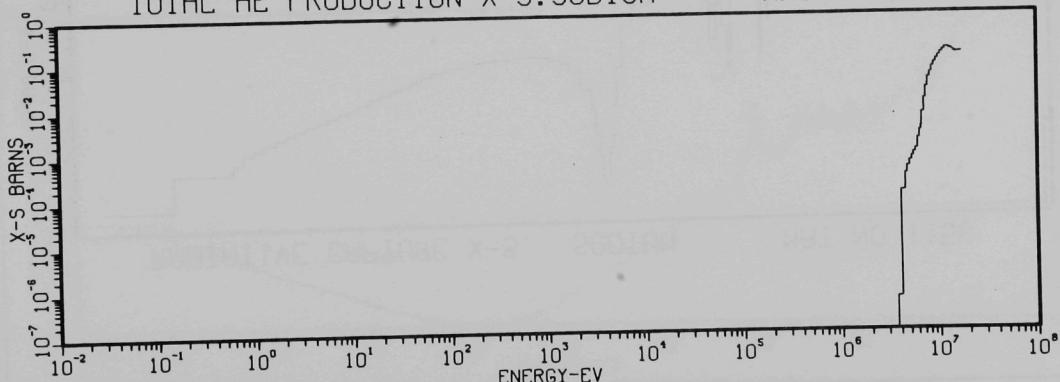
TOTAL H PRODUCTION X-S. SODIUM

MAT NO 1156



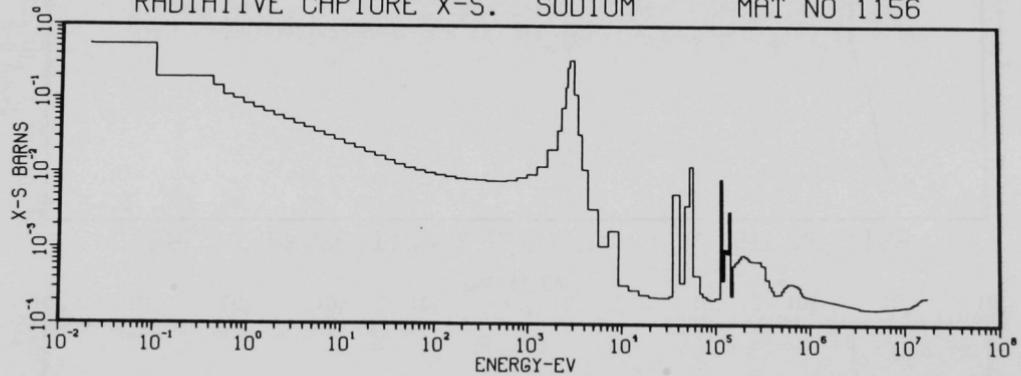
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MAT NO 1156



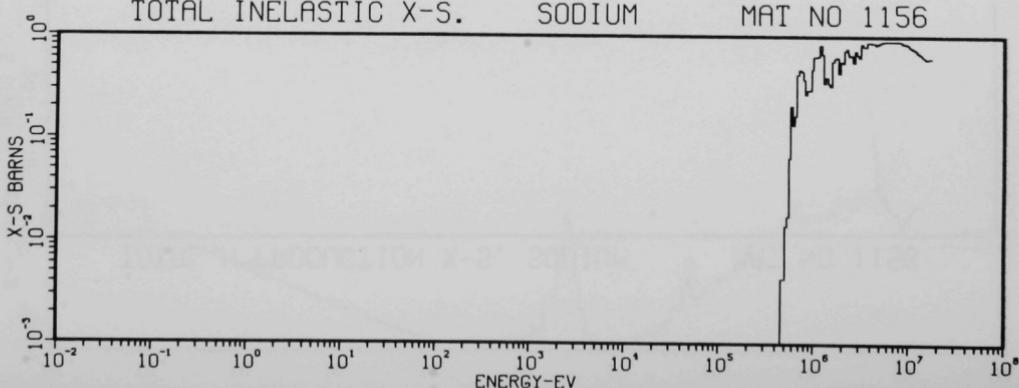
RADIATIVE CAPTURE X-S. SODIUM

MAT NO 1156



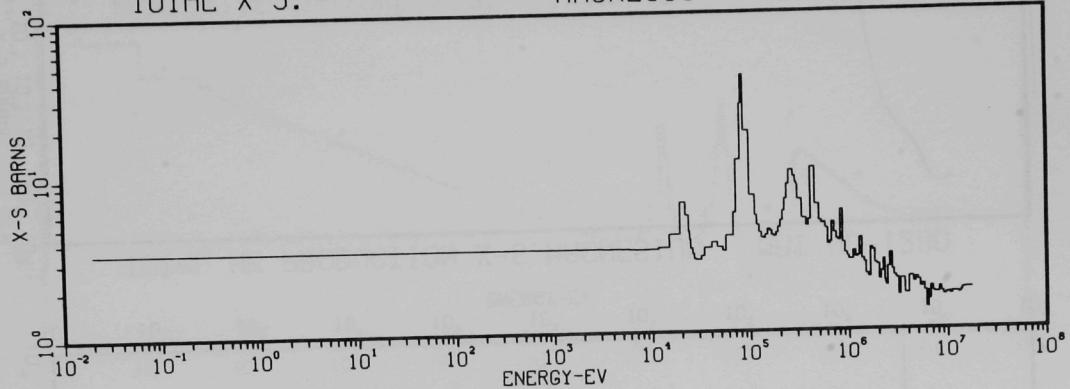
TOTAL INELASTIC X-S. SODIUM

MAT NO 1156

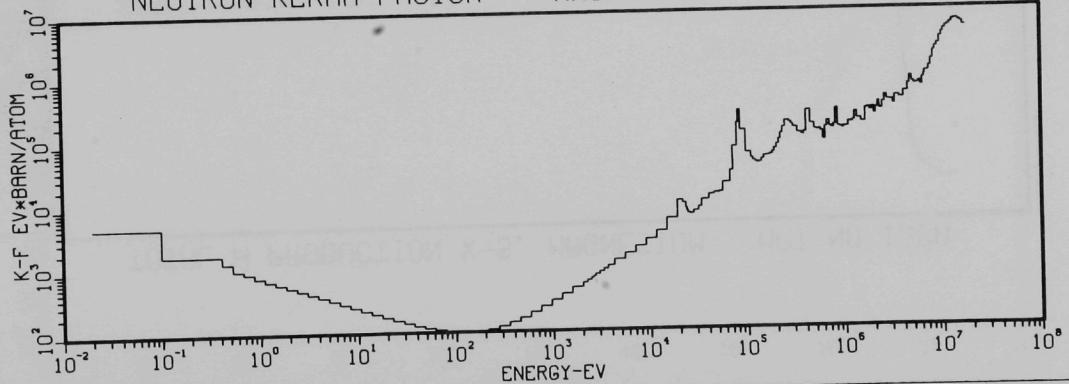


TOTAL X-S.

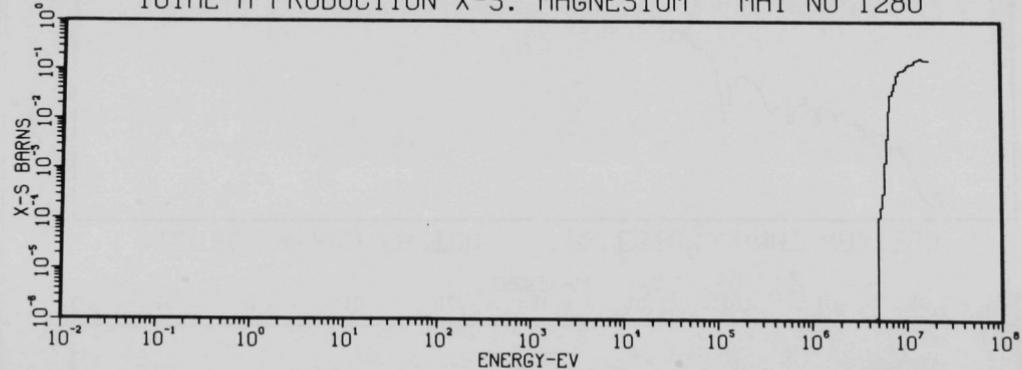
MAGNESIUM MAT NO 1280



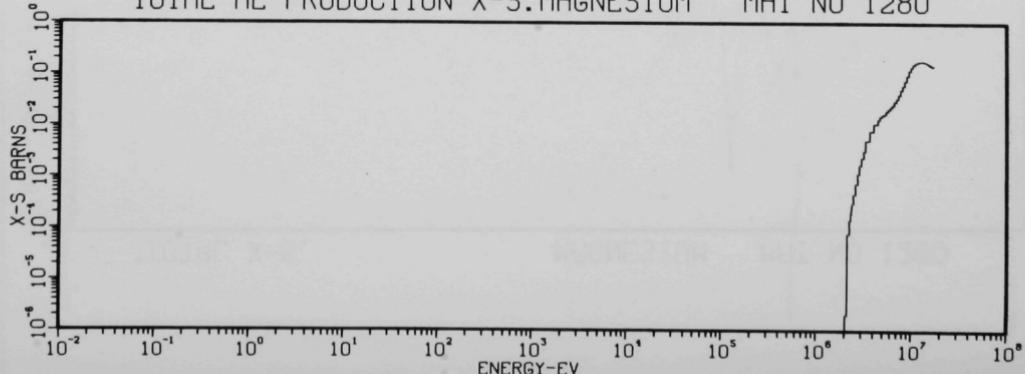
NEUTRON KERMA FACTOR MAGNESIUM MAT NO 1280



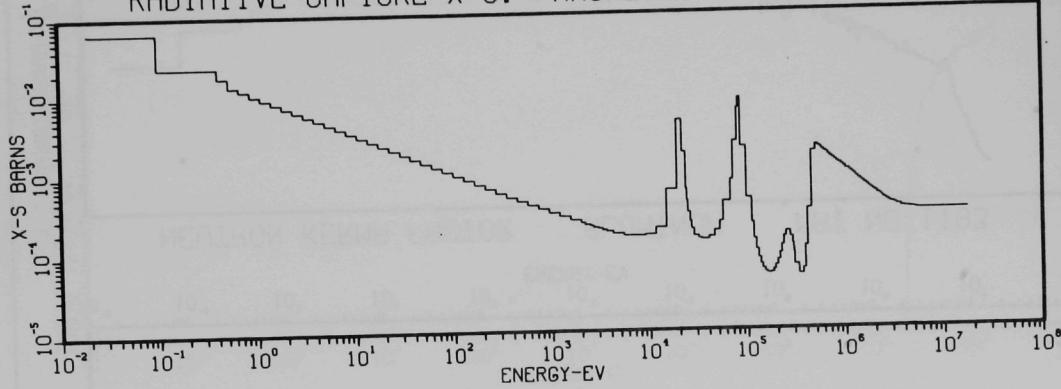
TOTAL H PRODUCTION X-S. MAGNESIUM MAT NO 1280



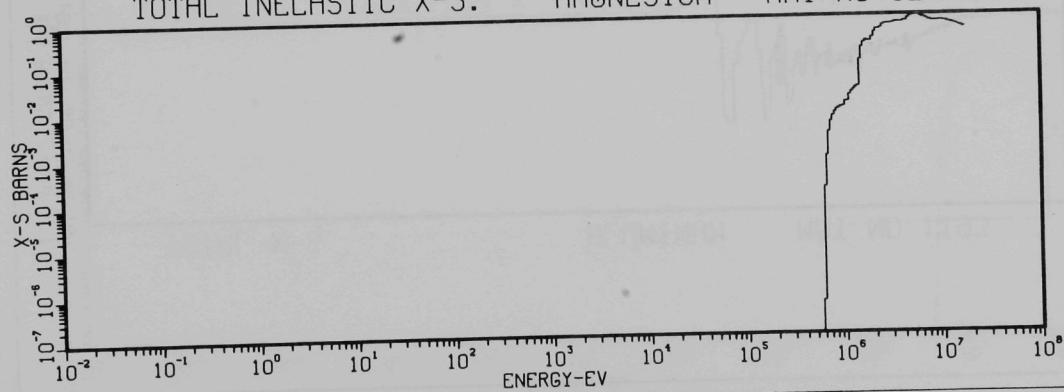
TOTAL HE PRODUCTION X-S.MAGNESIUM MAT NO 1280

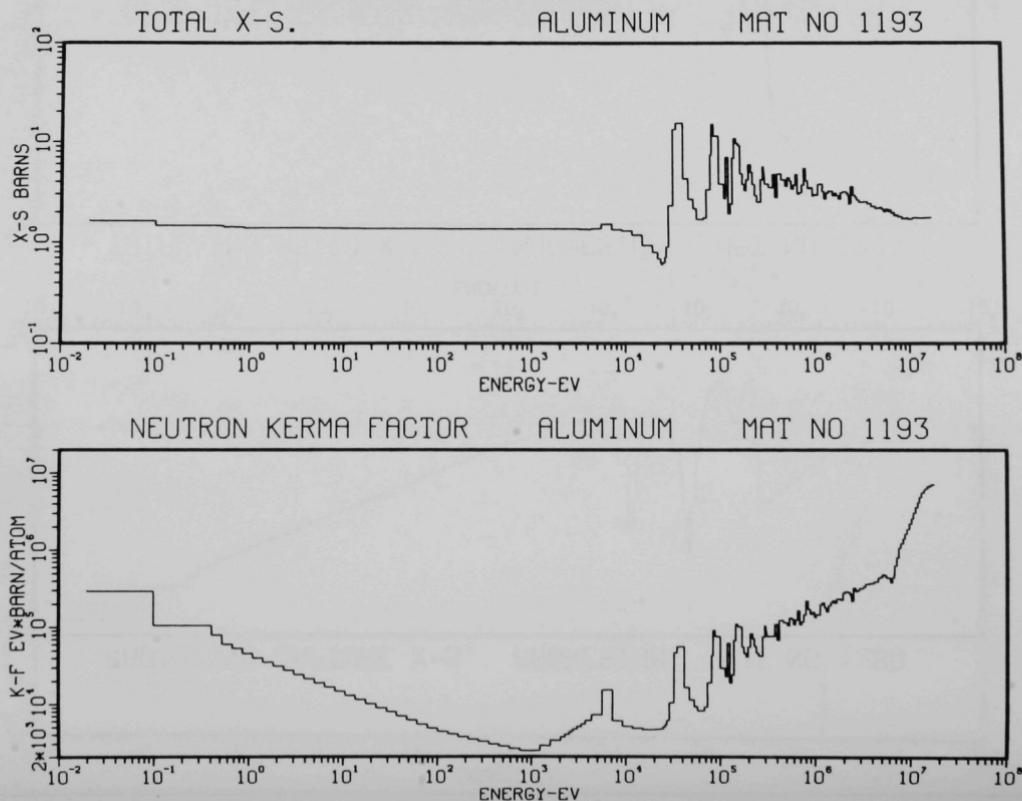


RADIATIVE CAPTURE X-S. MAGNESIUM MAT NO 1280



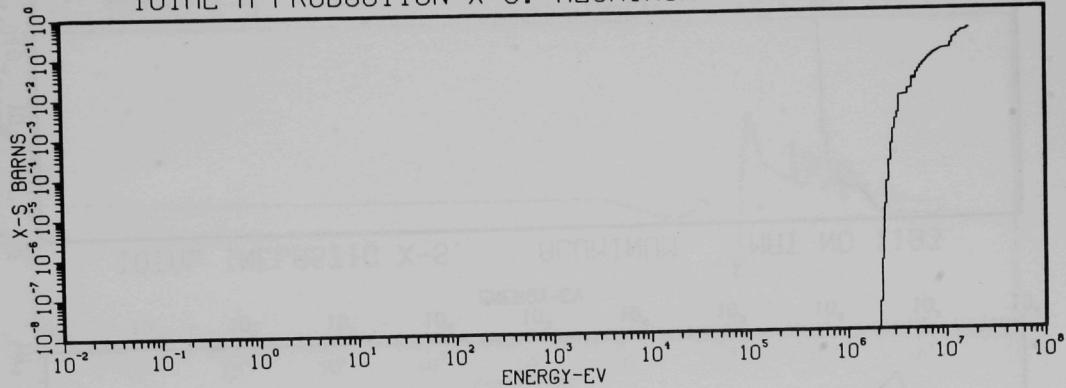
TOTAL INELASTIC X-S. MAGNESIUM MAT NO 1280





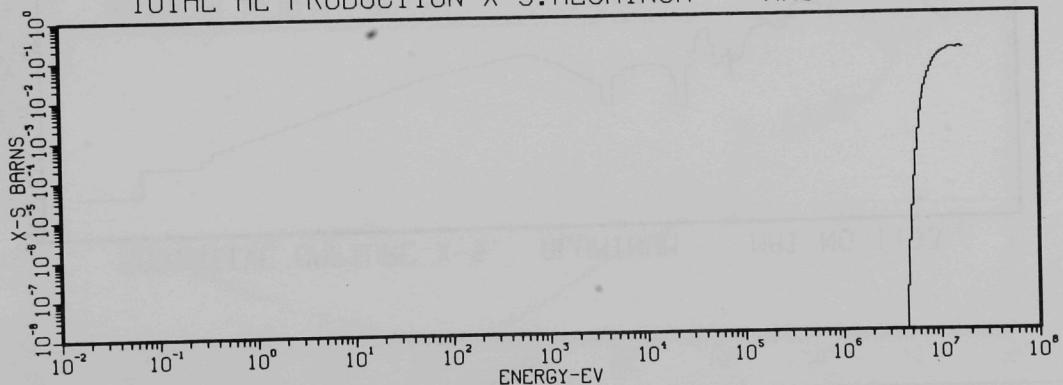
TOTAL H PRODUCTION X-S. ALUMINUM

MAT NO 1193



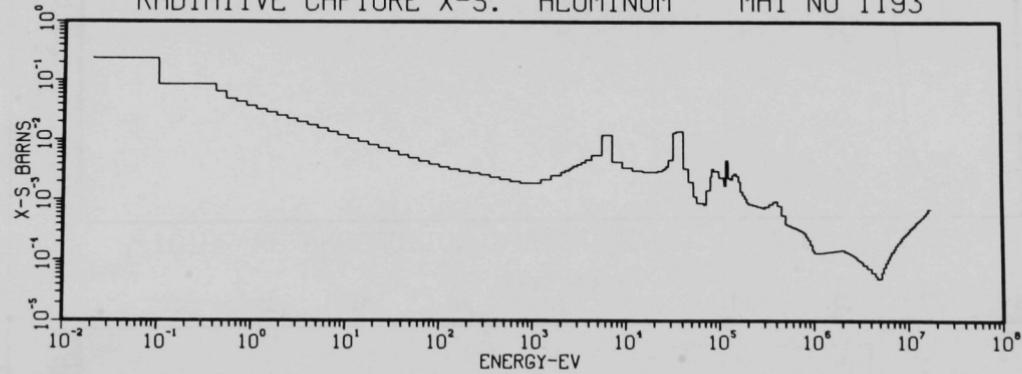
TOTAL HE PRODUCTION X-S. ALUMINUM

MAT NO 1193

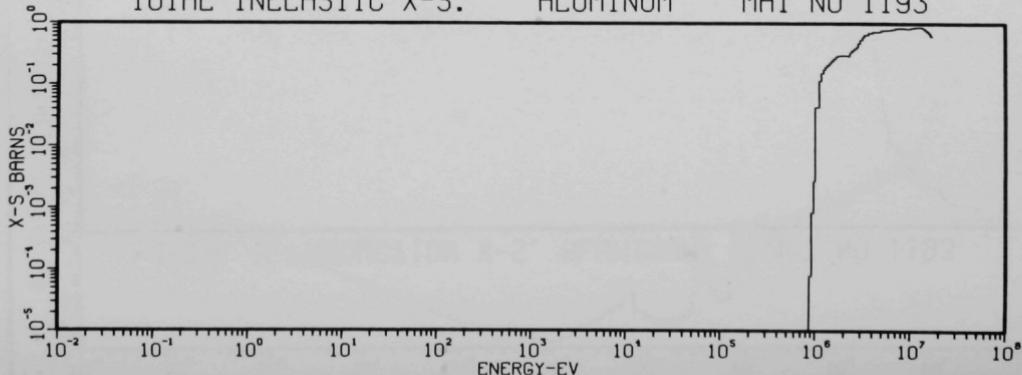


A-40

RADIATIVE CAPTURE X-S. ALUMINUM MAT NO 1193



TOTAL INELASTIC X-S. ALUMINUM MAT NO 1193

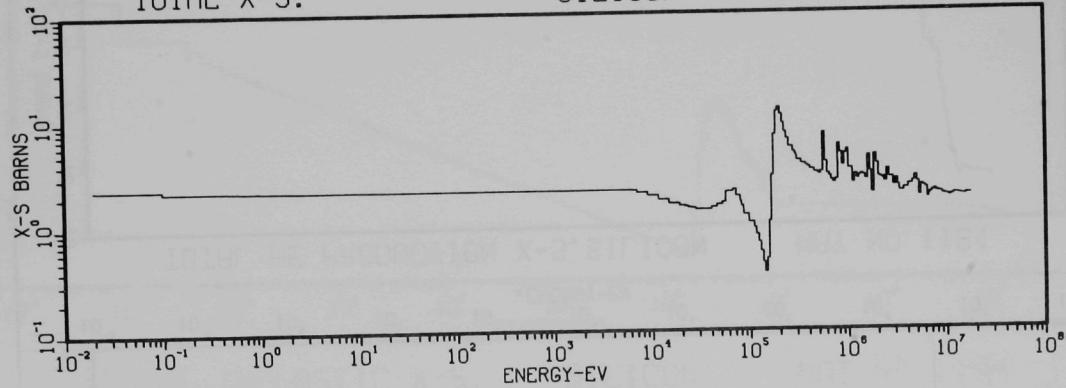


A-41

TOTAL X-S.

SILICON

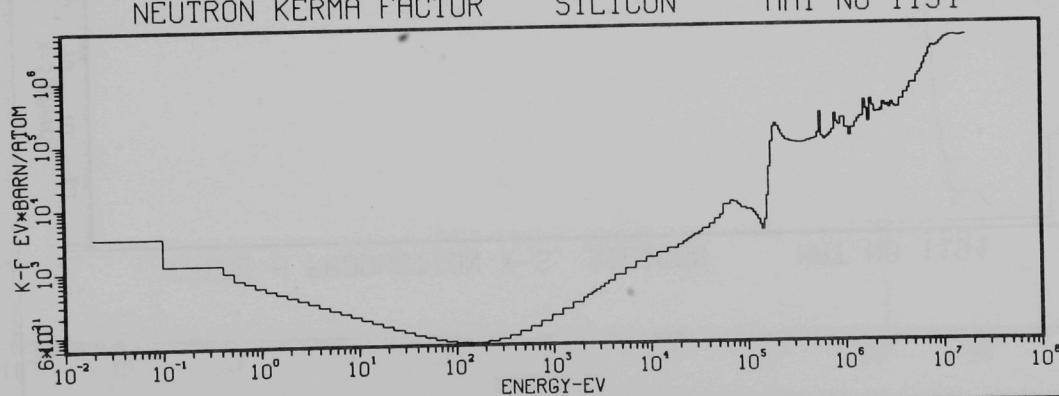
MAT NO 1194



NEUTRON KERMA FACTOR

SILICON

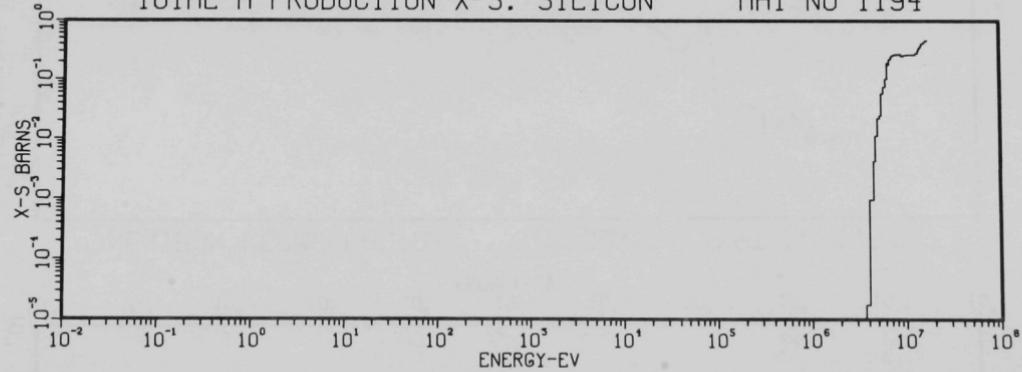
MAT NO 1194



A-42

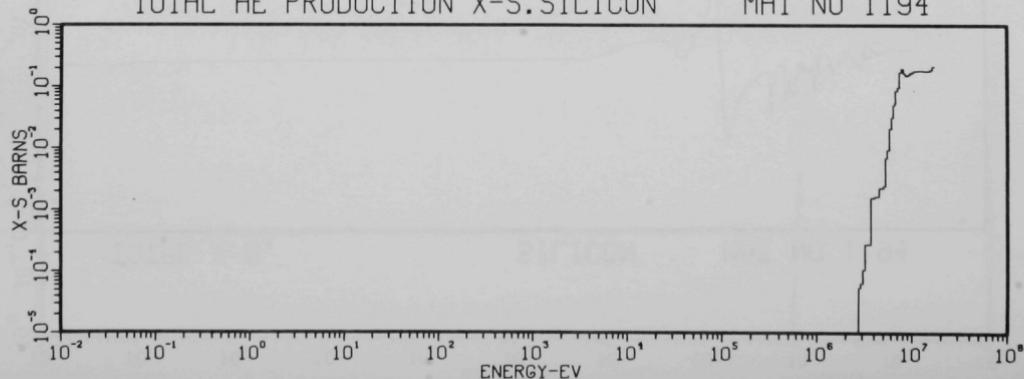
TOTAL H PRODUCTION X-S. SILICON

MAT NO 1194



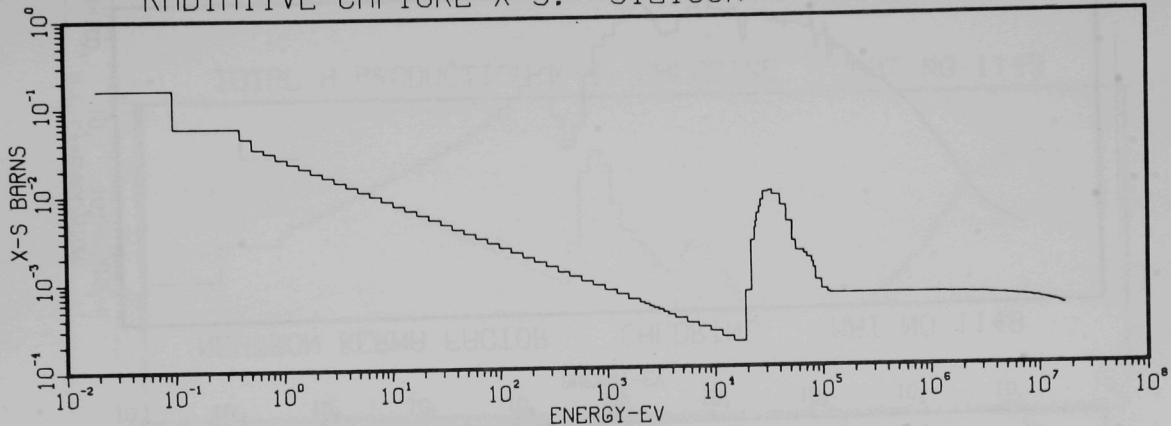
TOTAL HE PRODUCTION X-S.SILICON

MAT NO 1194



RADIATIVE CAPTURE X-S. SILICON

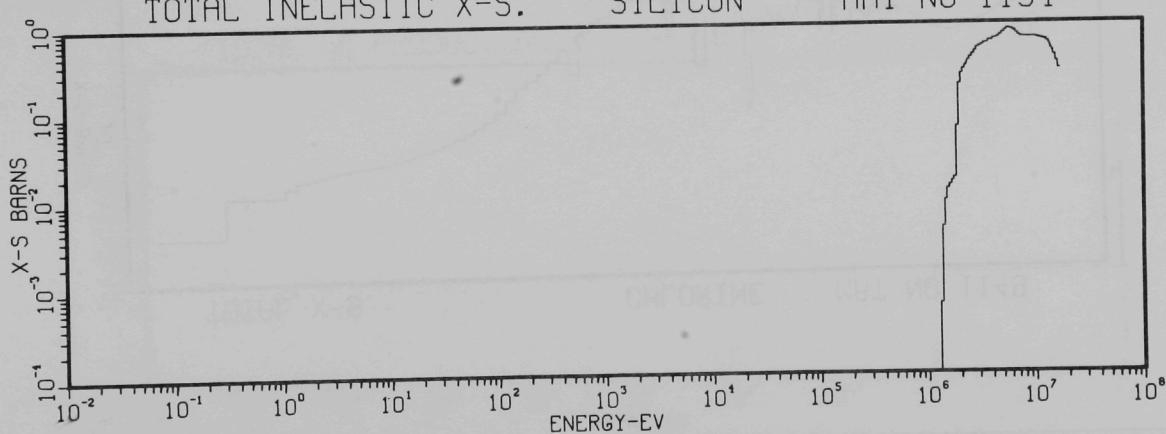
MAT NO 1194



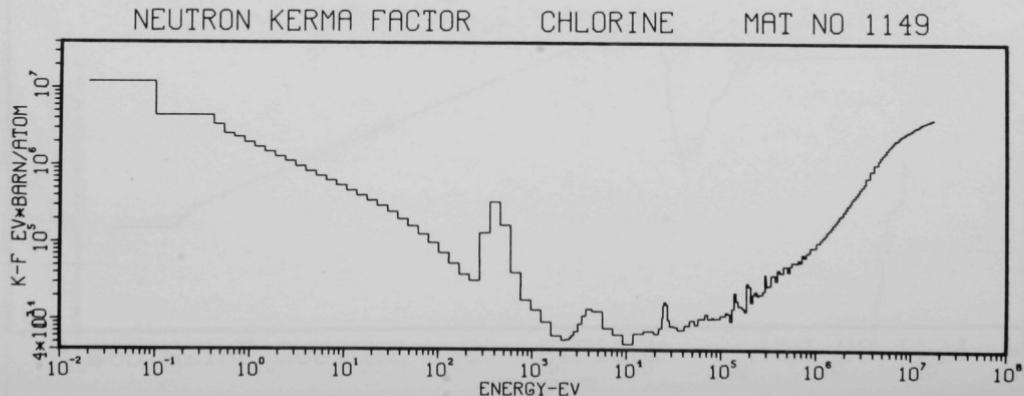
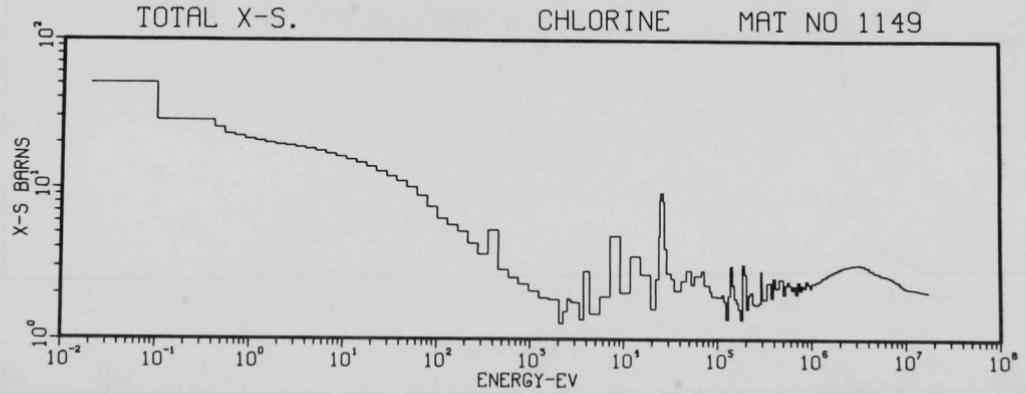
A-43

TOTAL INELASTIC X-S. SILICON

MAT NO 1194

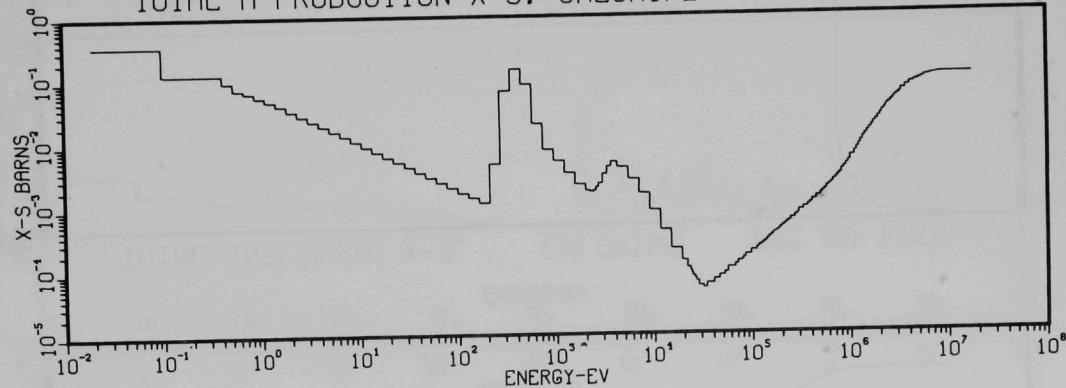


A-44



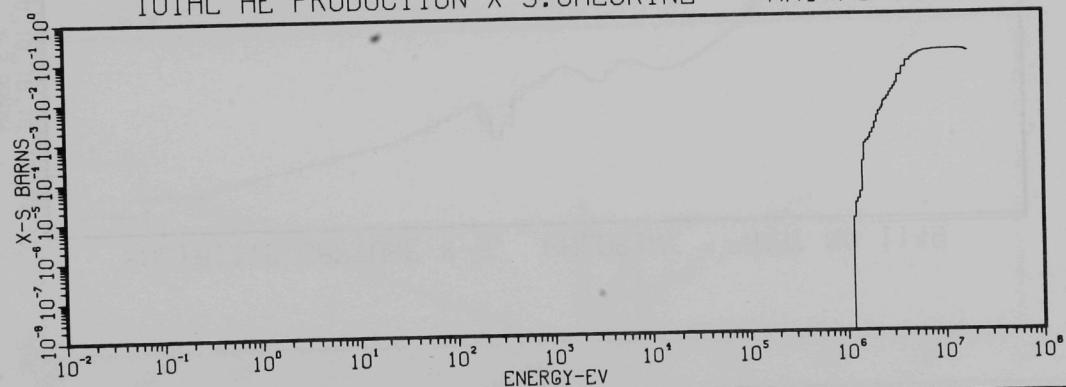
TOTAL H PRODUCTION X-S. CHLORINE

MAT NO 1149



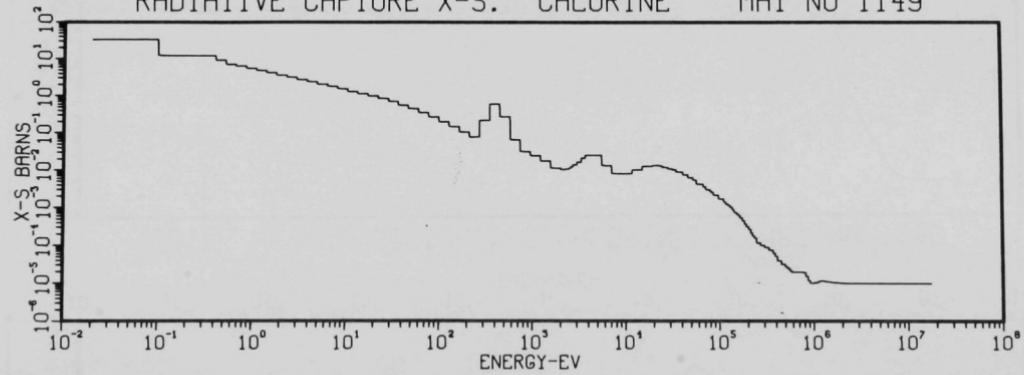
TOTAL HE PRODUCTION X-S. CHLORINE

MAT NO 1149

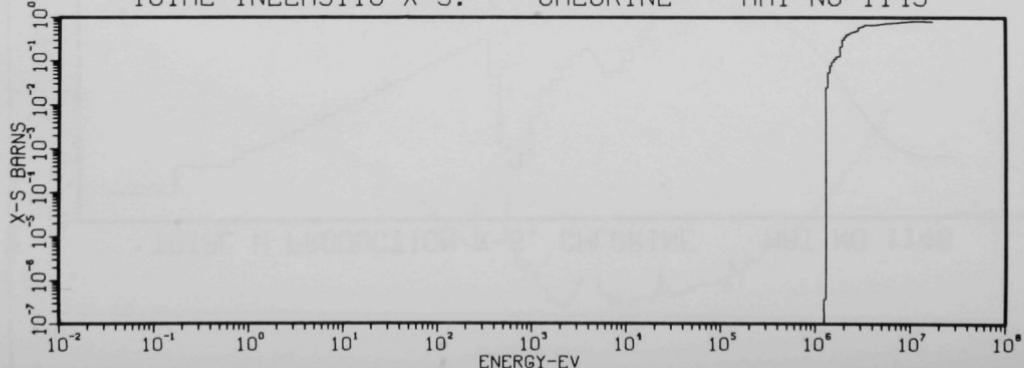


A-446

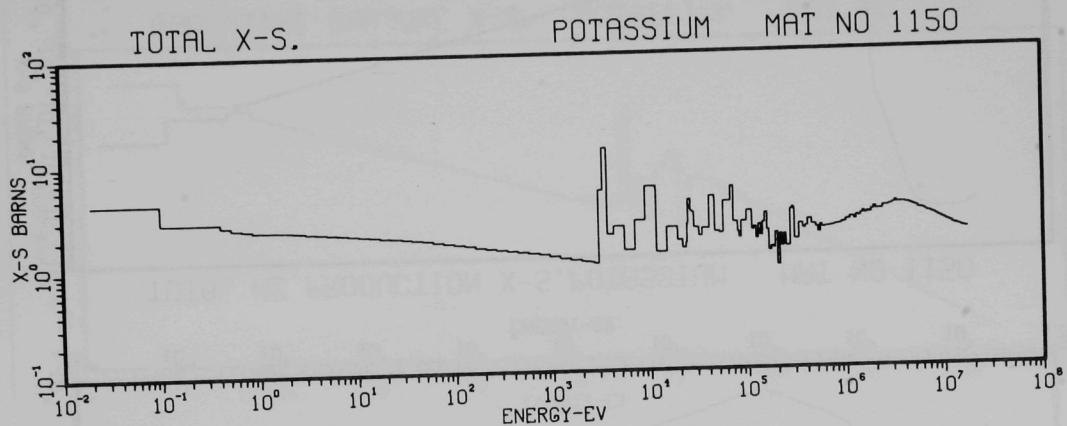
RADIATIVE CAPTURE X-S. CHLORINE MAT NO 1149



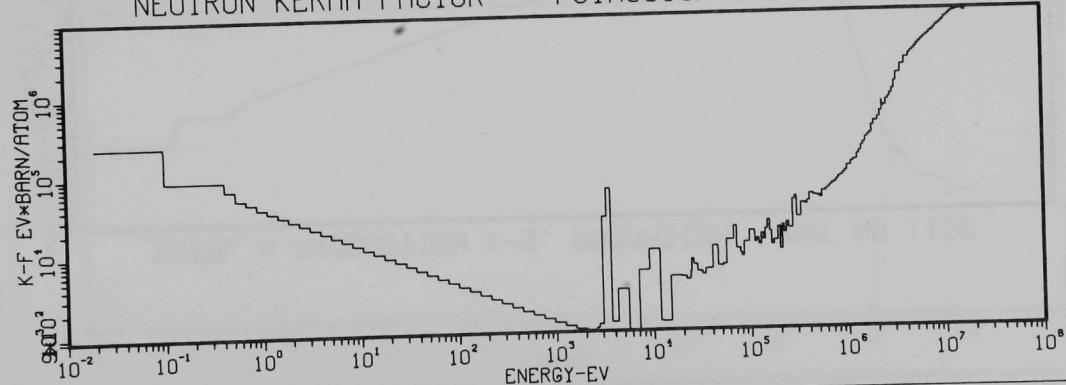
TOTAL INELASTIC X-S. CHLORINE MAT NO 1149



L4-A

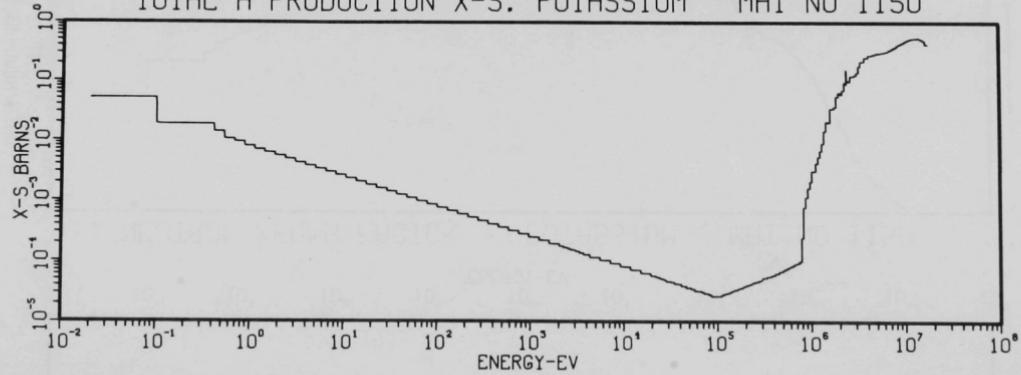


NEUTRON KERMA FACTOR POTASSIUM MAT NO 1150

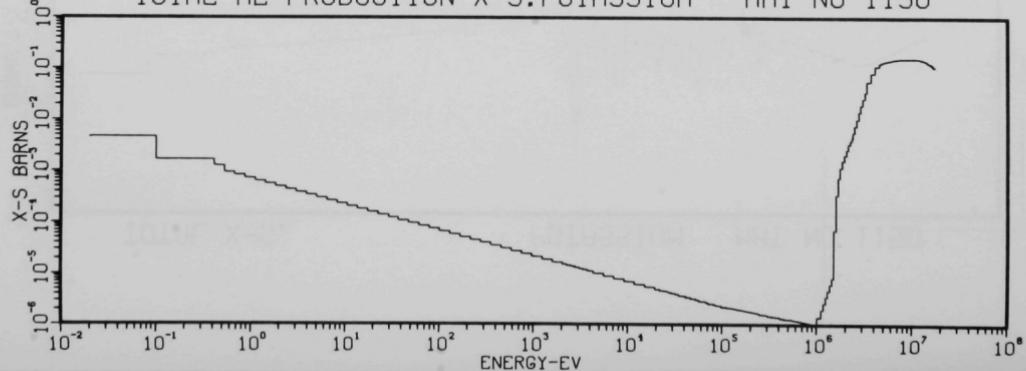


A-48

TOTAL H PRODUCTION X-S. POTASSIUM MAT NO 1150

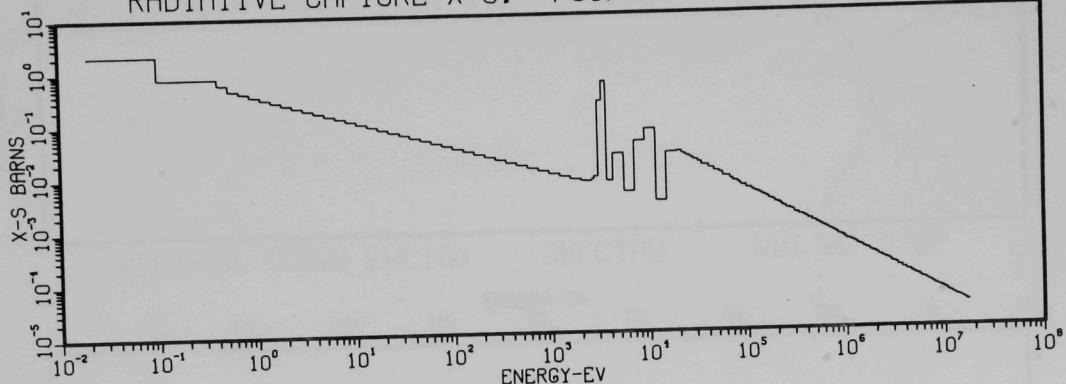


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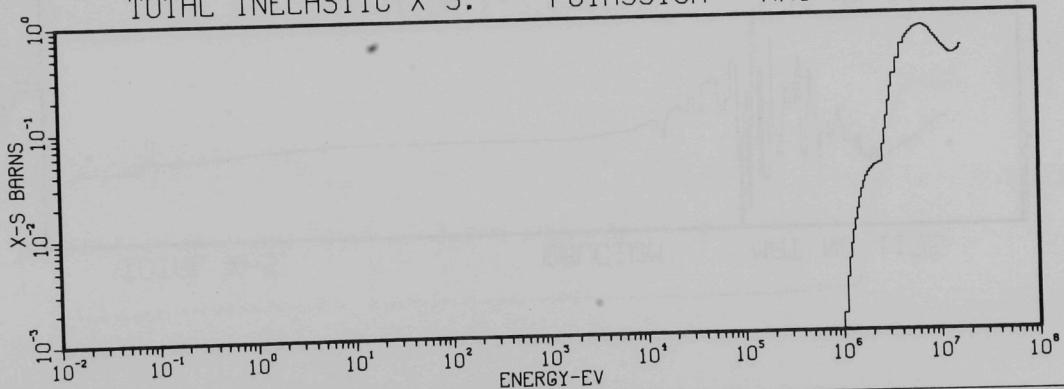


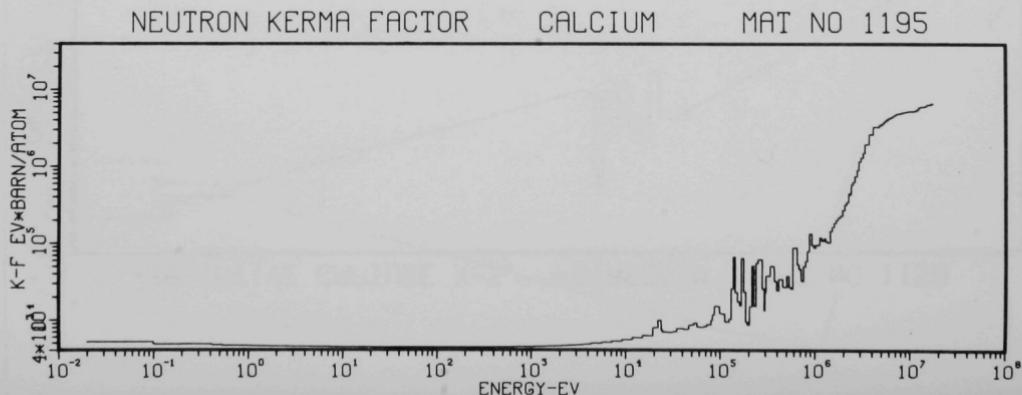
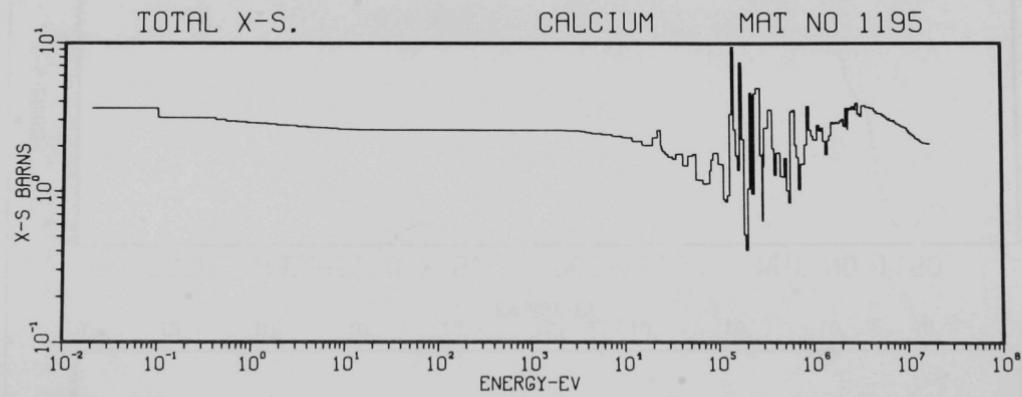
A-49

RADIATIVE CAPTURE X-S. POTASSIUM MAT NO 1150



TOTAL INELASTIC X-S. POTASSIUM MAT NO 1150

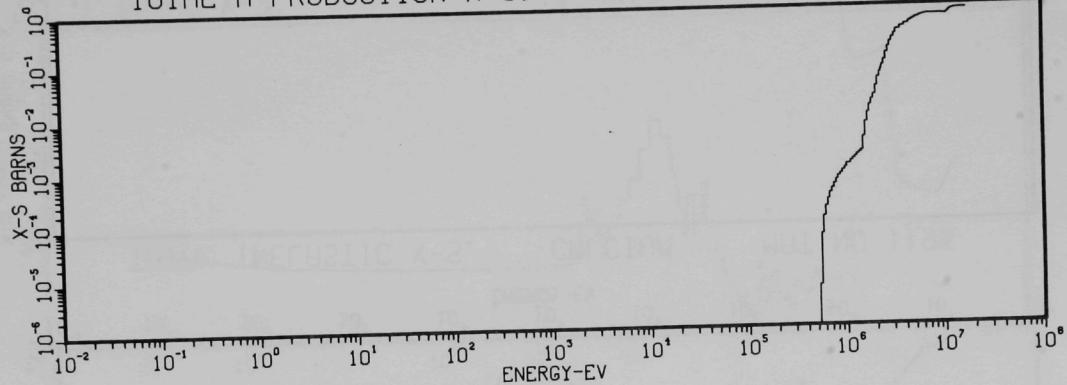




A-51

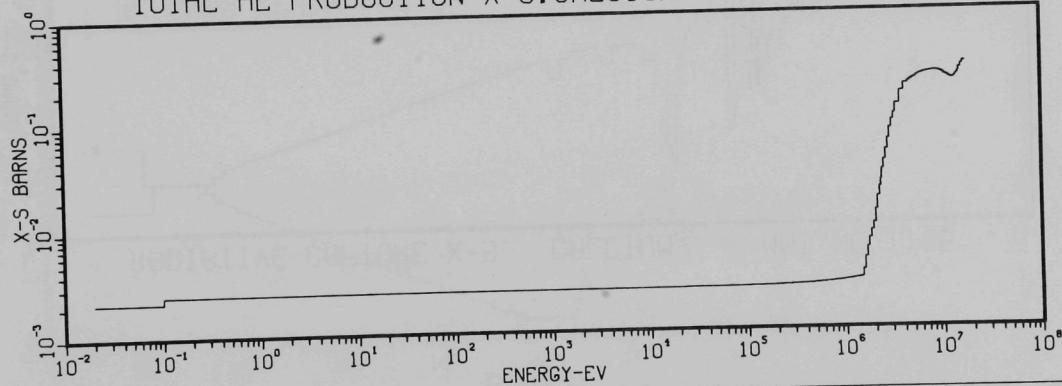
TOTAL H PRODUCTION X-S. CALCIUM

MAT NO 1195

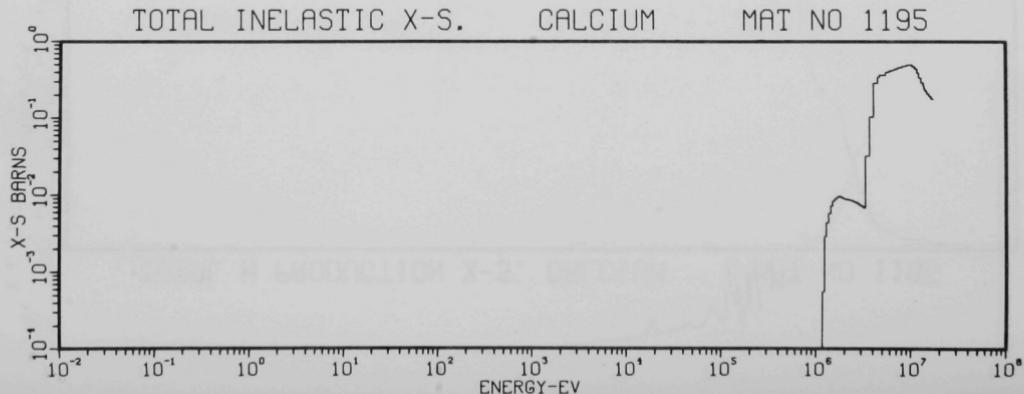
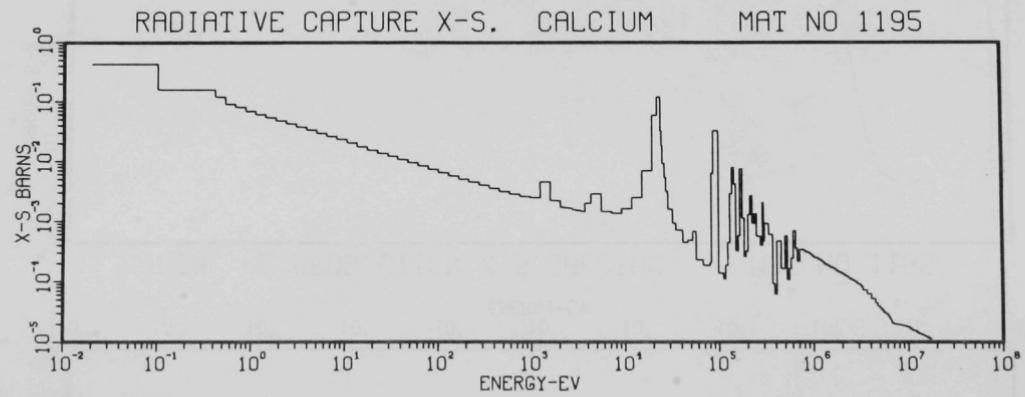


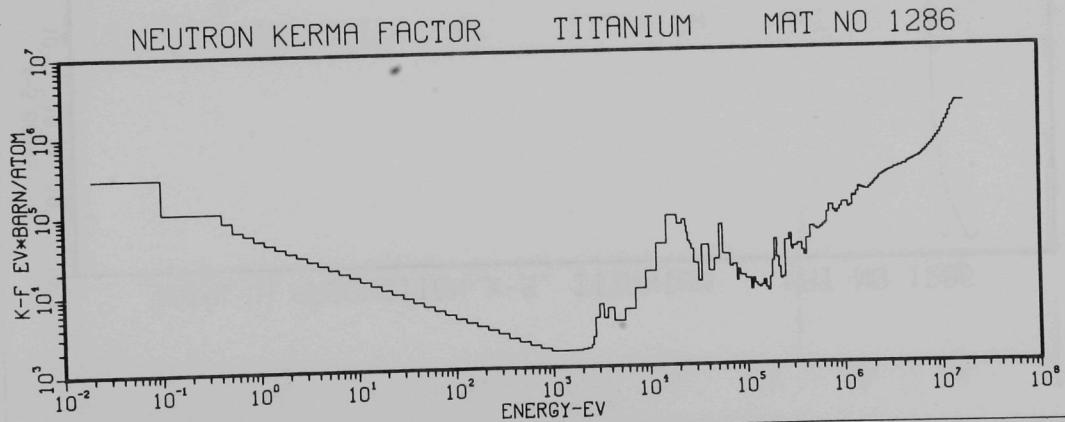
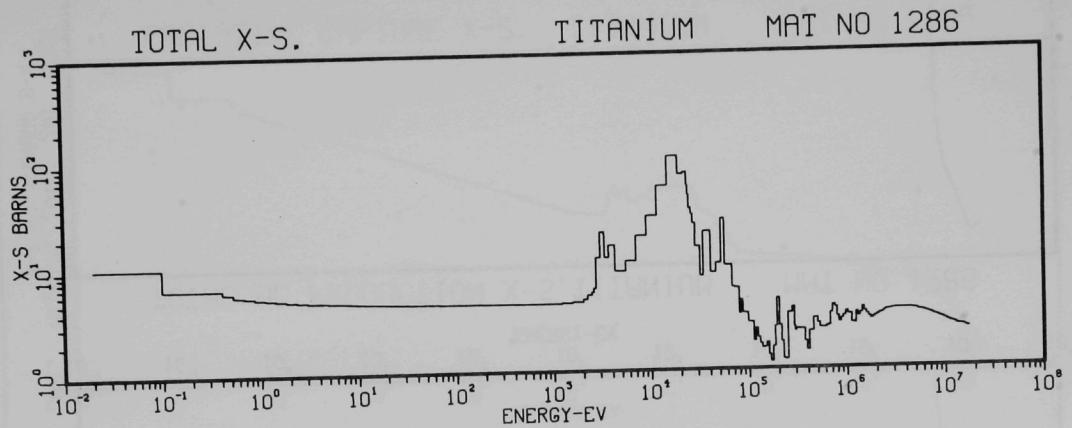
TOTAL HE PRODUCTION X-S.CALCIUM

MAT NO 1195



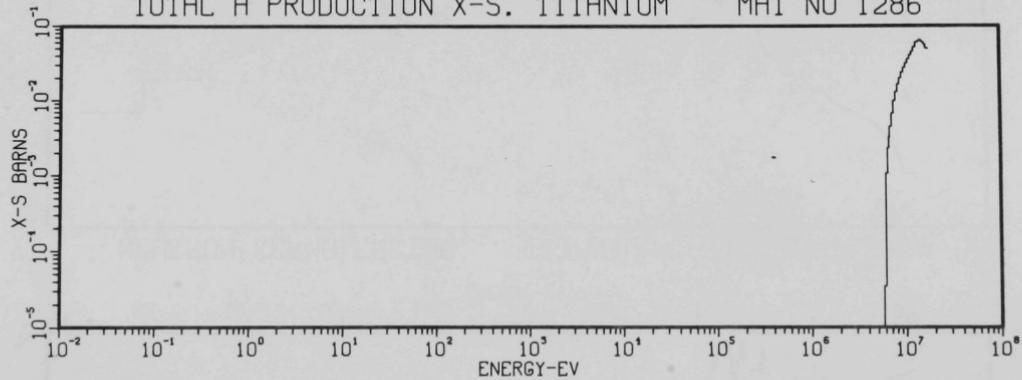
A-52



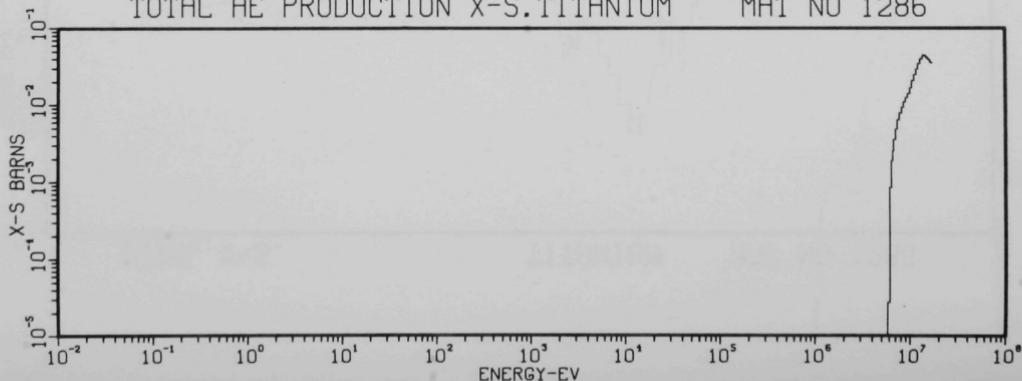


A-54

TOTAL H PRODUCTION X-S. TITANIUM MAT NO 1286

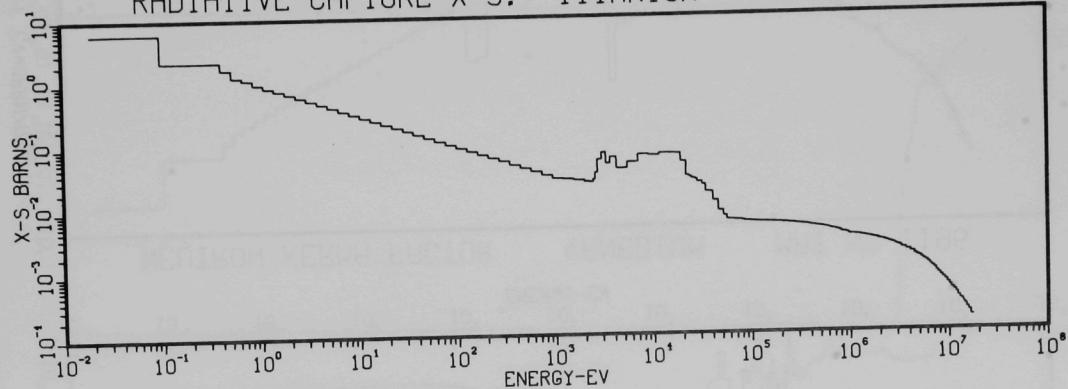


TOTAL HE PRODUCTION X-S.TITANIUM MAT NO 1286

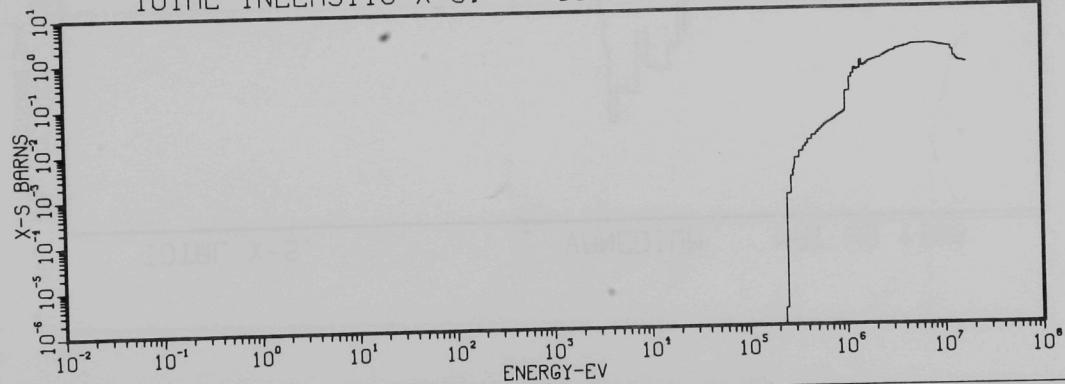


55-A

RADIATIVE CAPTURE X-S. TITANIUM MAT NO 1286



TOTAL INELASTIC X-S. TITANIUM MAT NO 1286

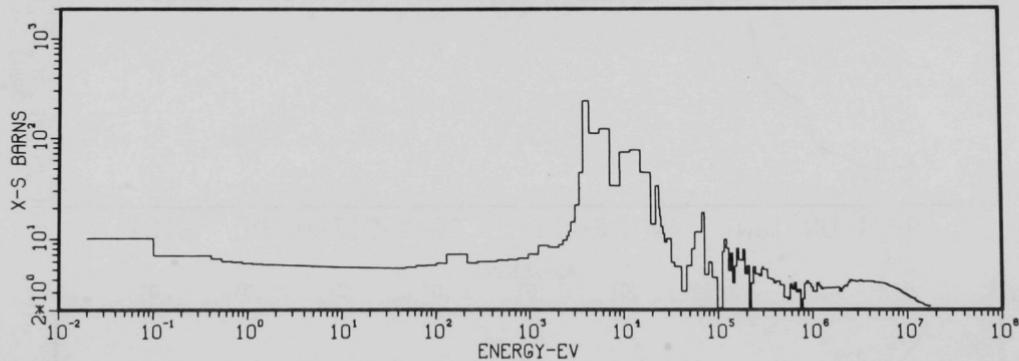


95A

TOTAL X-S.

VANIDIUM

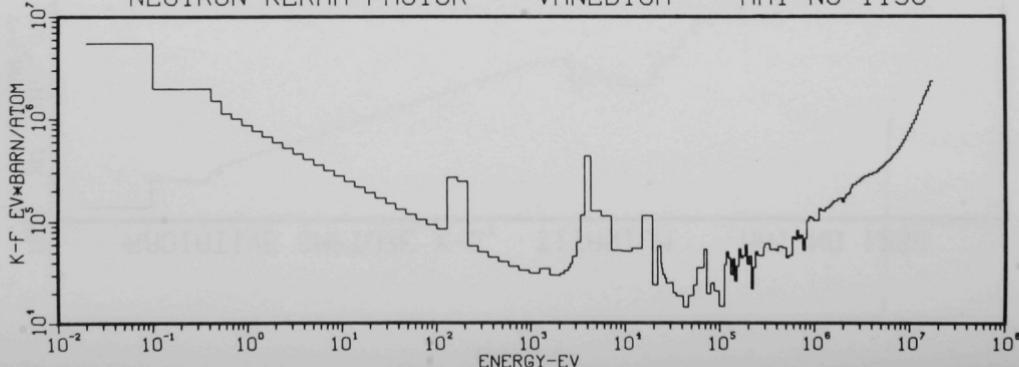
MAT NO 1196



NEUTRON KERMA FACTOR

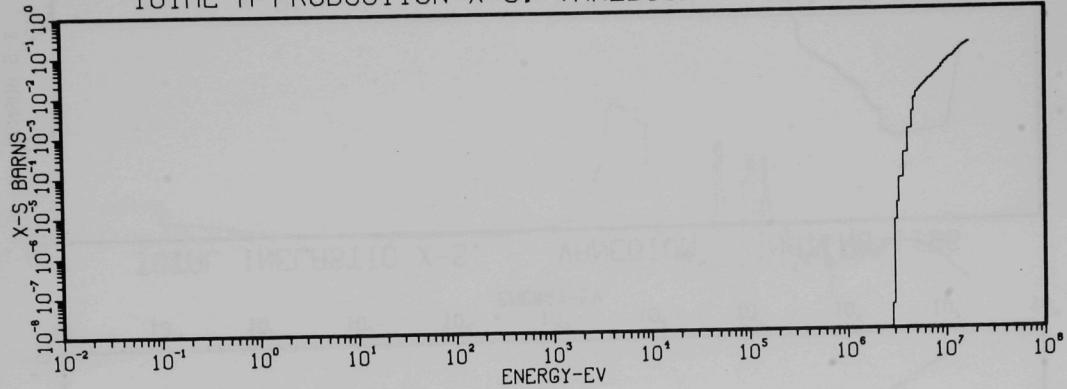
VANIDIUM

MAT NO 1196



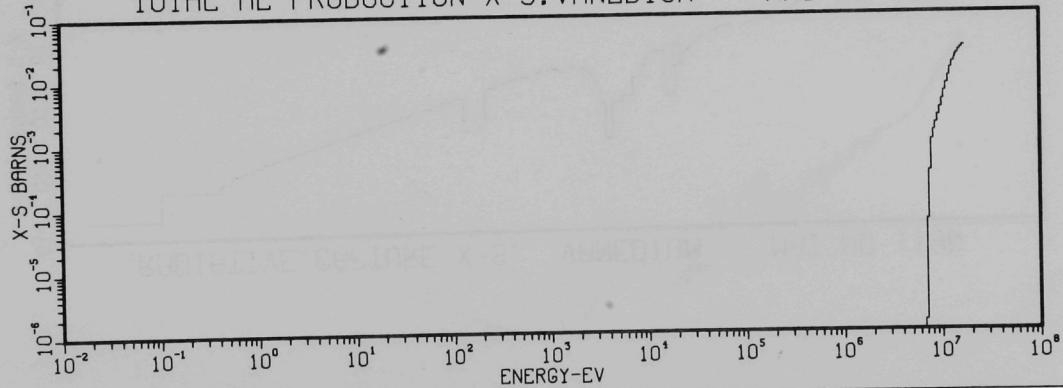
TOTAL H PRODUCTION X-S. VANADIUM

MAT NO 1196

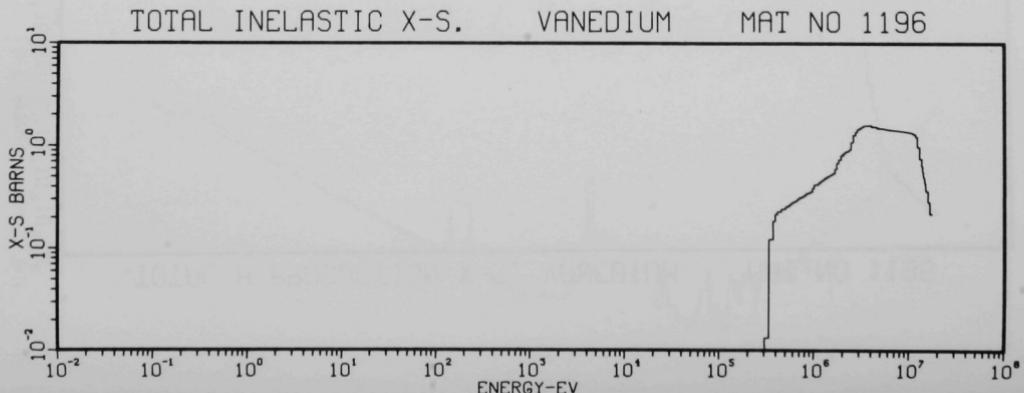
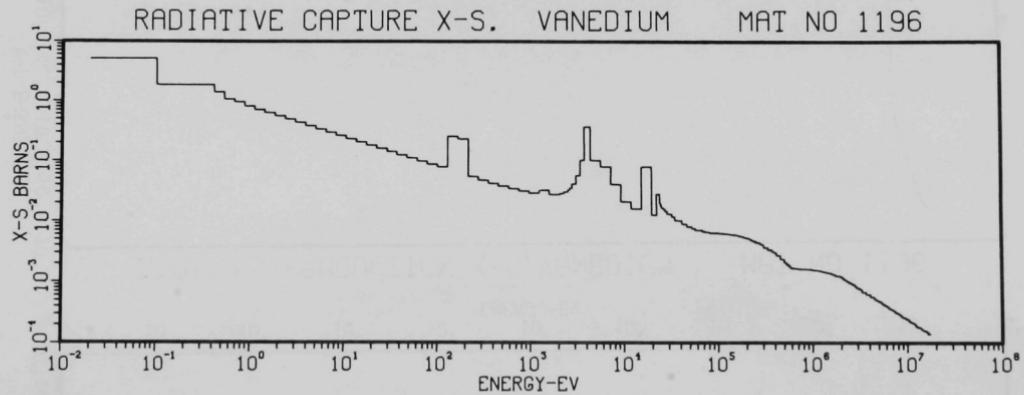


TOTAL HE PRODUCTION X-S. VANADIUM

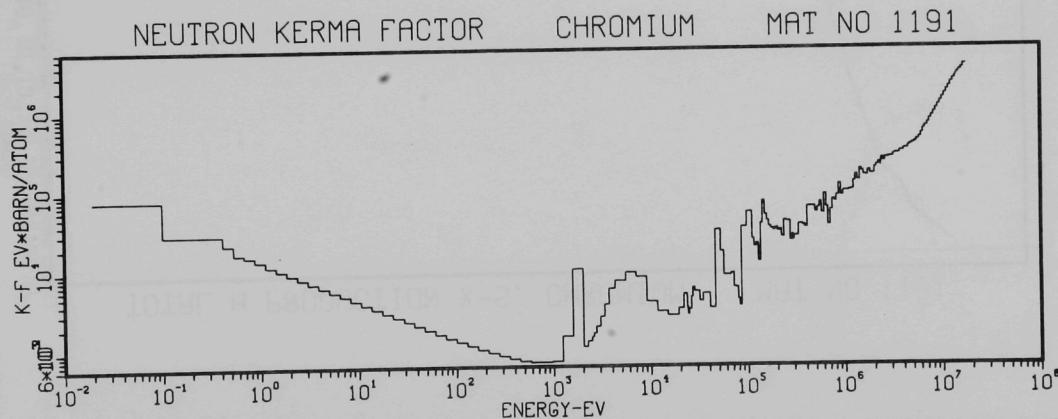
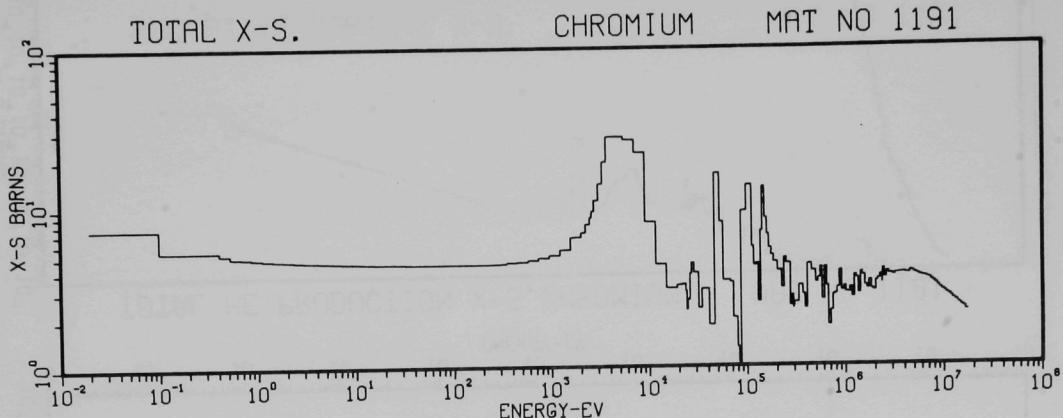
MAT NO 1196



A-53

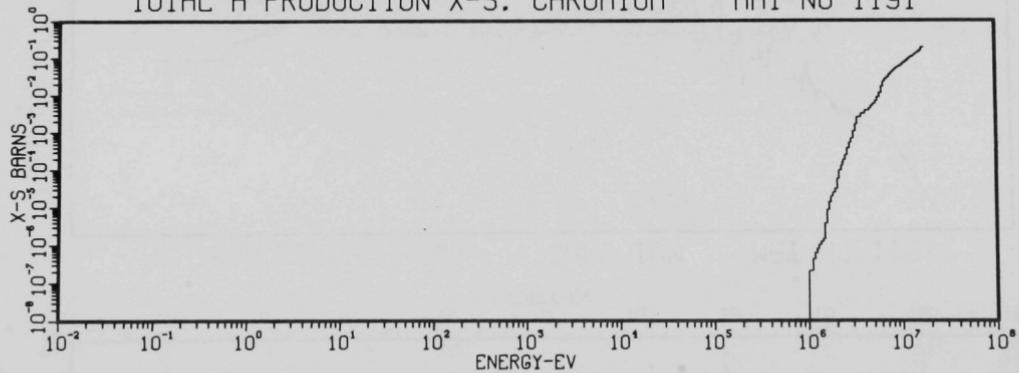


69-V

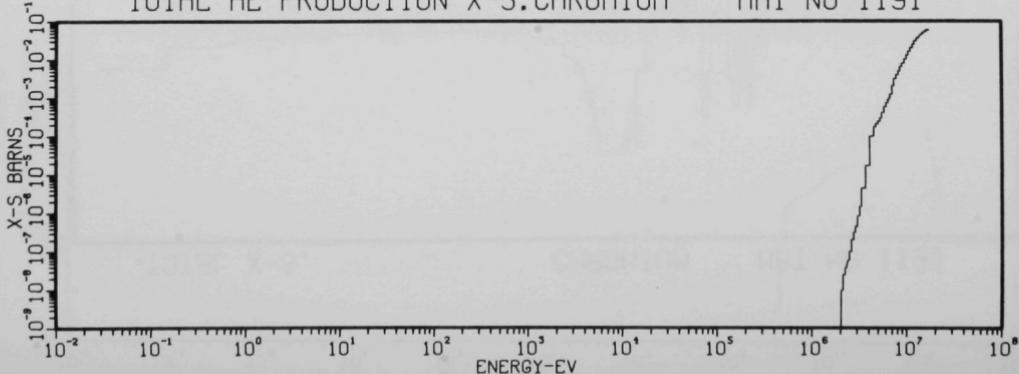


A-6

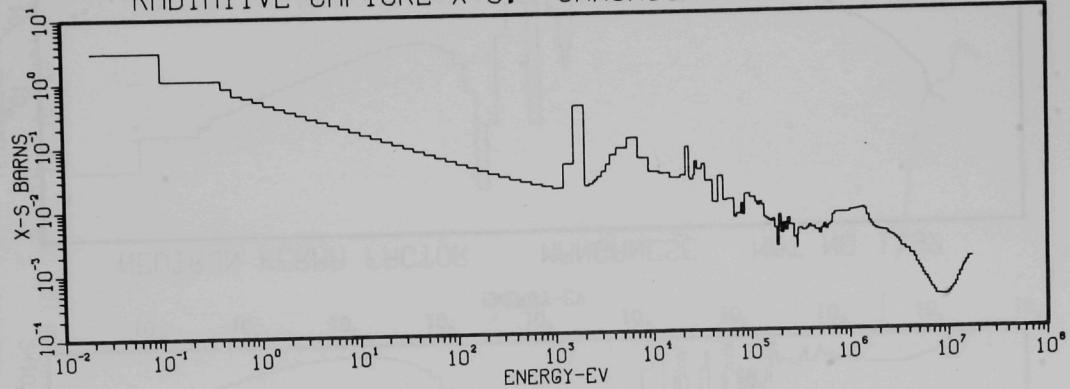
TOTAL H PRODUCTION X-S. CHROMIUM MAT NO 1191



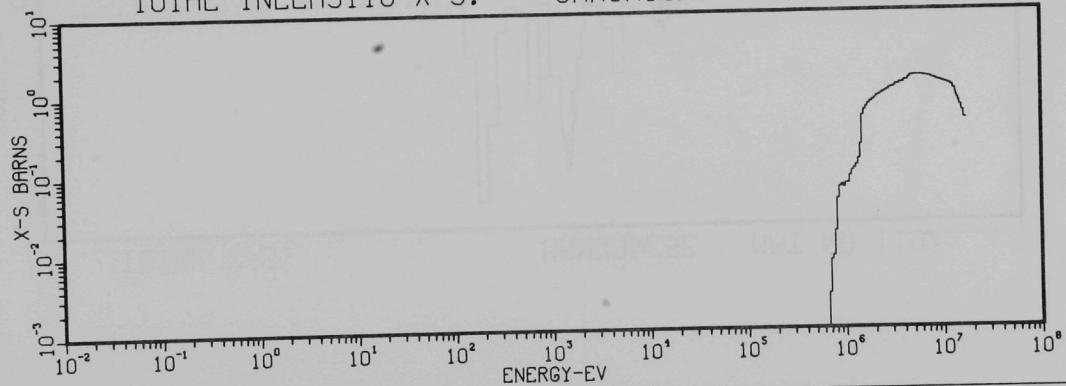
TOTAL HE PRODUCTION X-S.CHROMIUM MAT NO 1191



RADIATIVE CAPTURE X-S. CHROMIUM MAT NO 1191



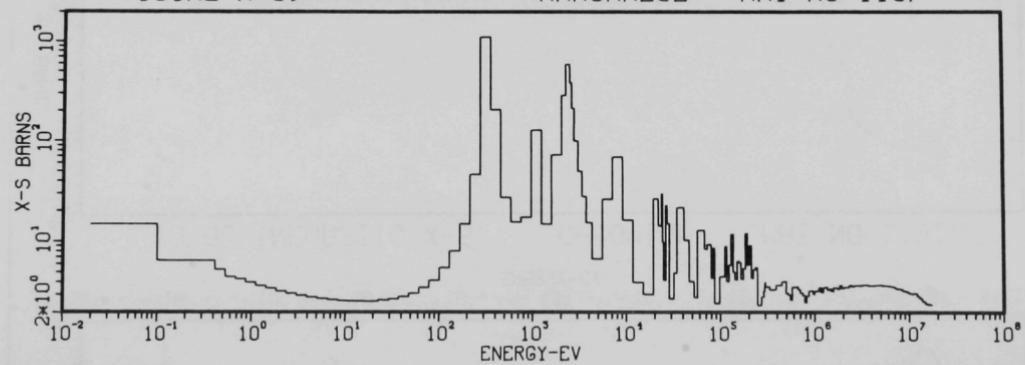
TOTAL INELASTIC X-S. CHROMIUM MAT NO 1191



19-A

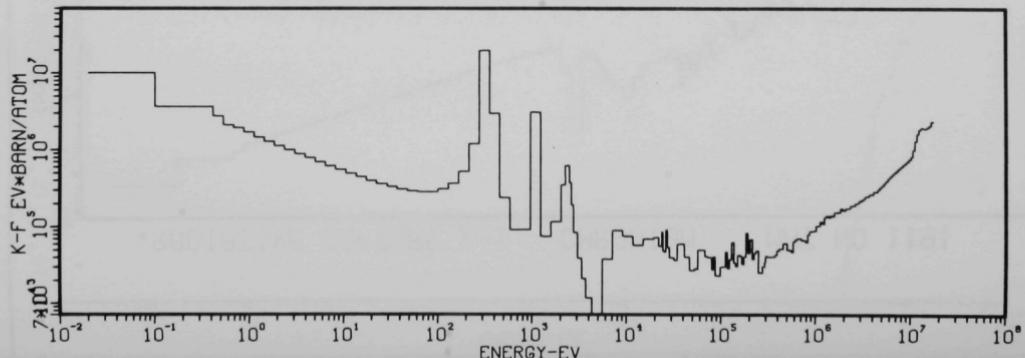
TOTAL X-S.

MANGANESE MAT NO 1197

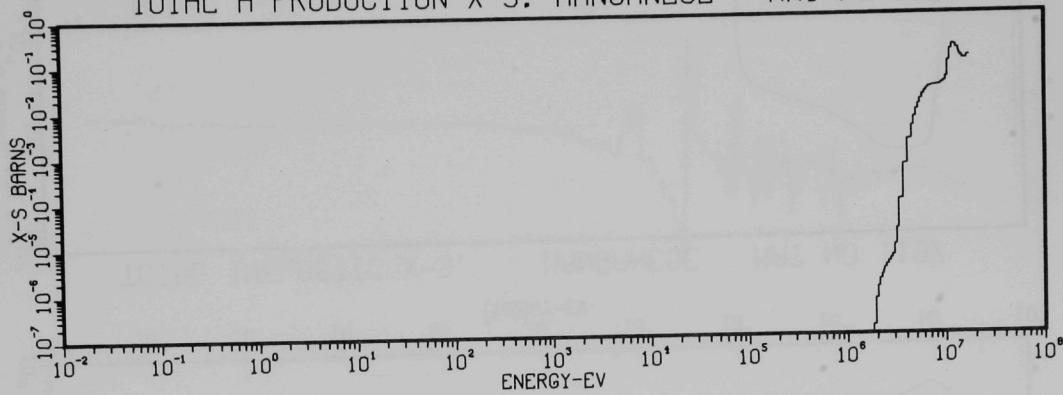


NEUTRON KERMA FACTOR

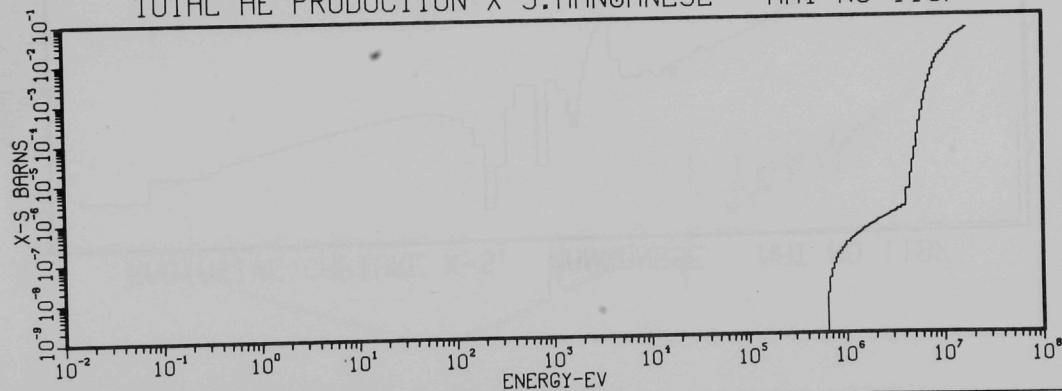
MANGANESE MAT NO 1197



TOTAL H PRODUCTION X-S. MANGANESE MAT NO 1197

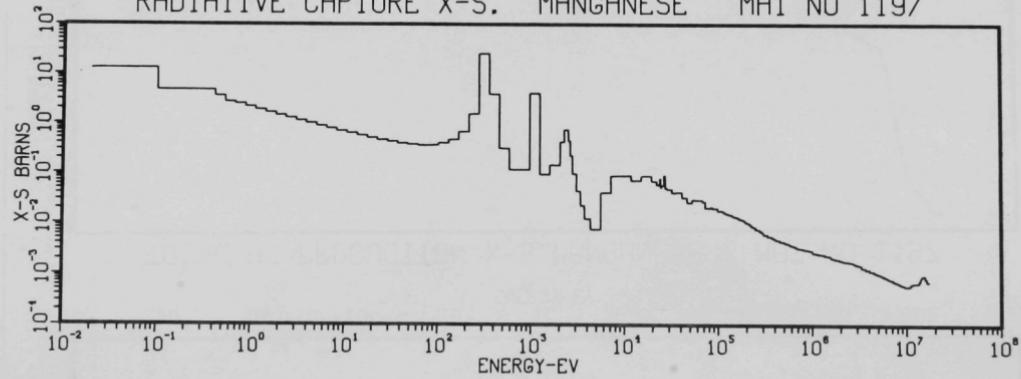


TOTAL HE PRODUCTION X-S. MANGANESE MAT NO 1197

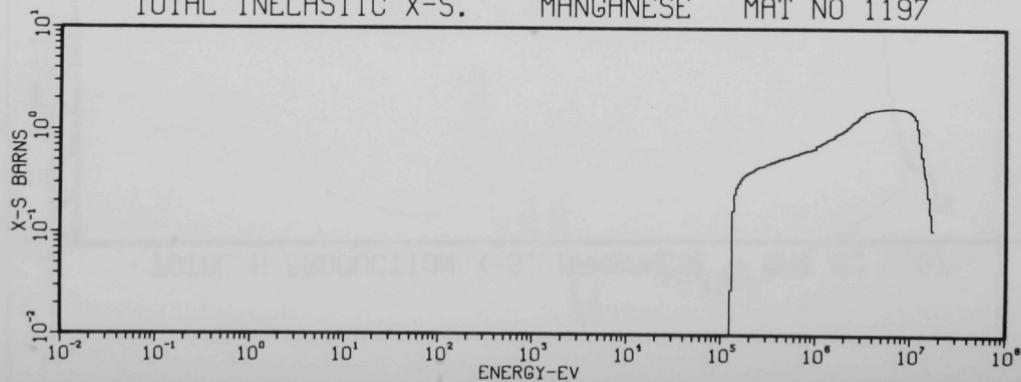


A-64

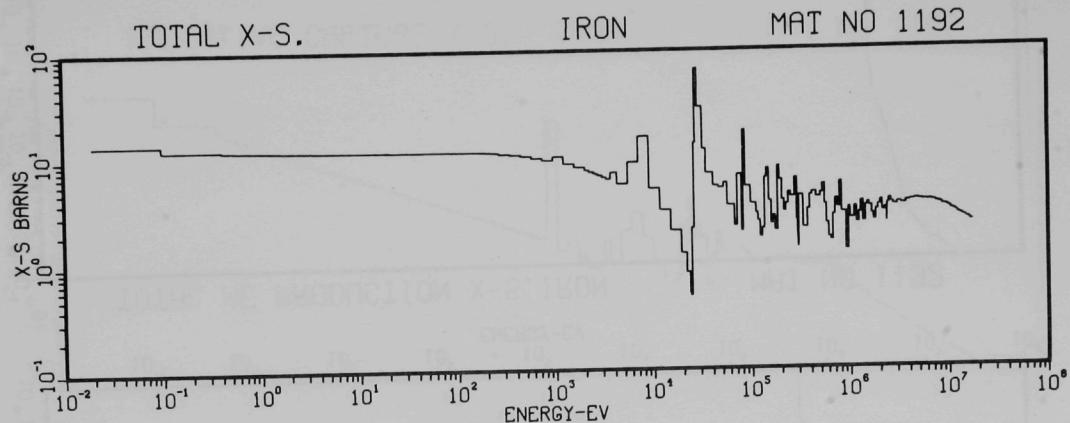
RADIATIVE CAPTURE X-S. MANGANESE MAT NO 1197



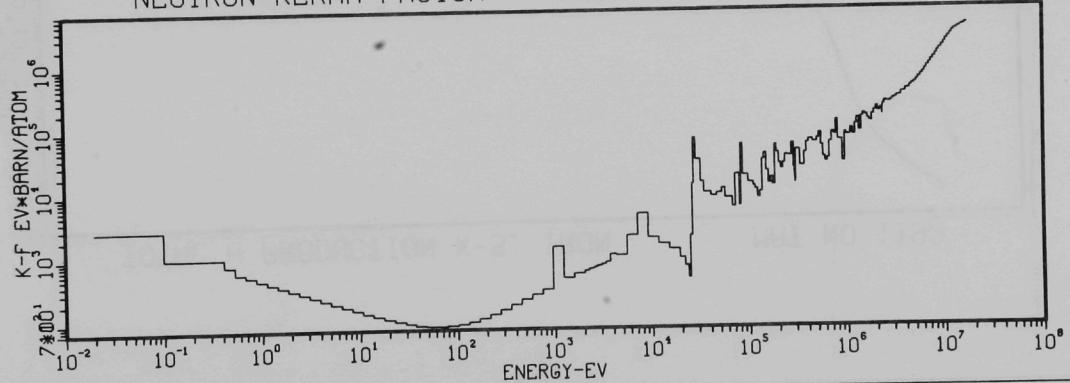
TOTAL INELASTIC X-S. MANGANESE MAT NO 1197



59-A



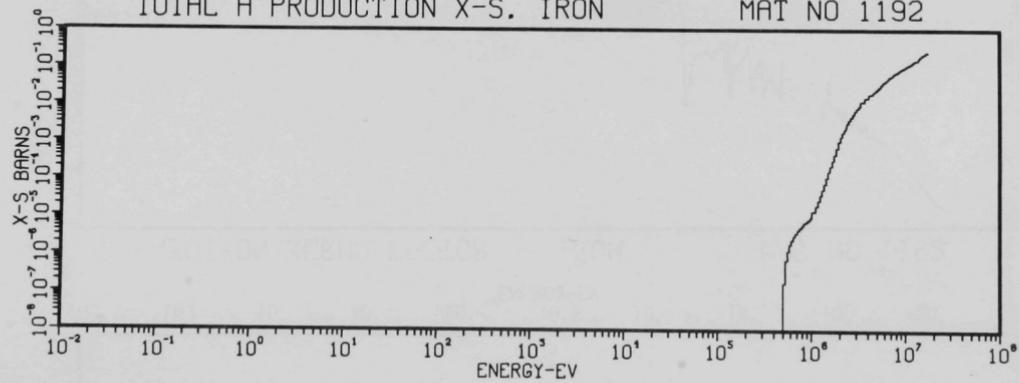
NEUTRON KERMA FACTOR IRON MAT NO 1192



99-A

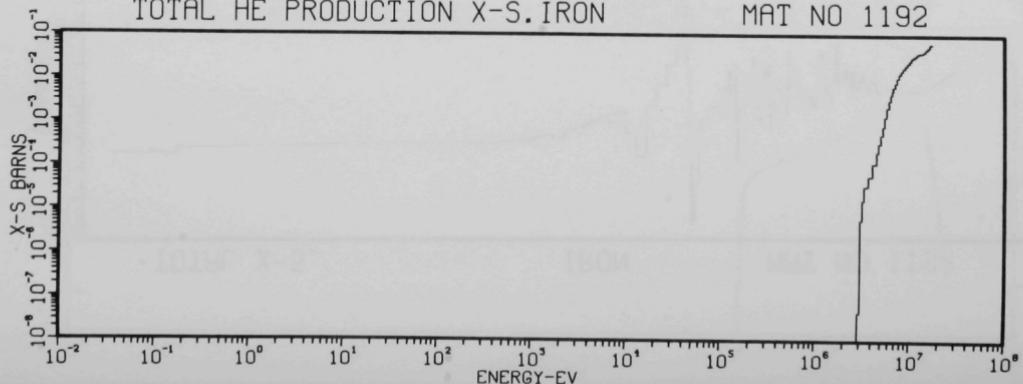
TOTAL H PRODUCTION X-S. IRON

MAT NO 1192



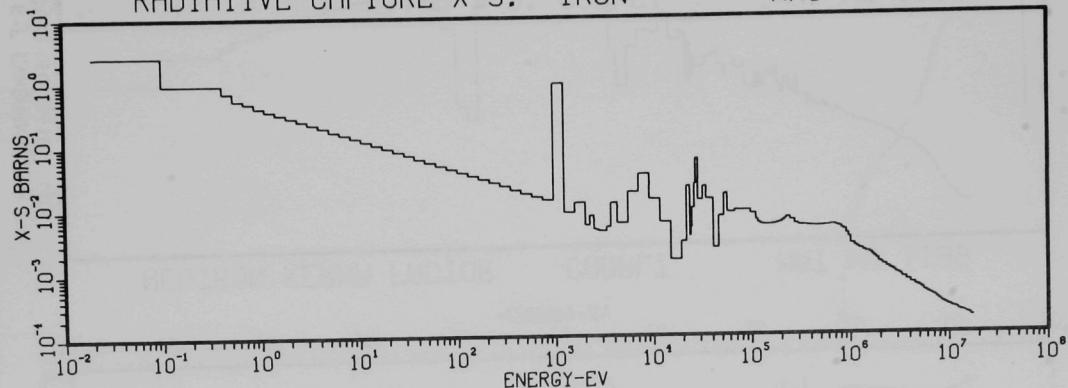
TOTAL HE PRODUCTION X-S. IRON

MAT NO 1192



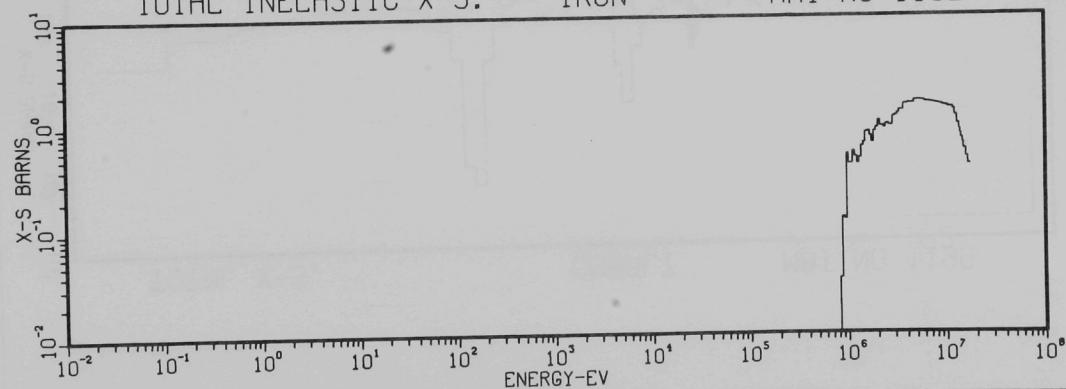
RADIATIVE CAPTURE X-S. IRON

MAT NO 1192



TOTAL INELASTIC X-S. IRON

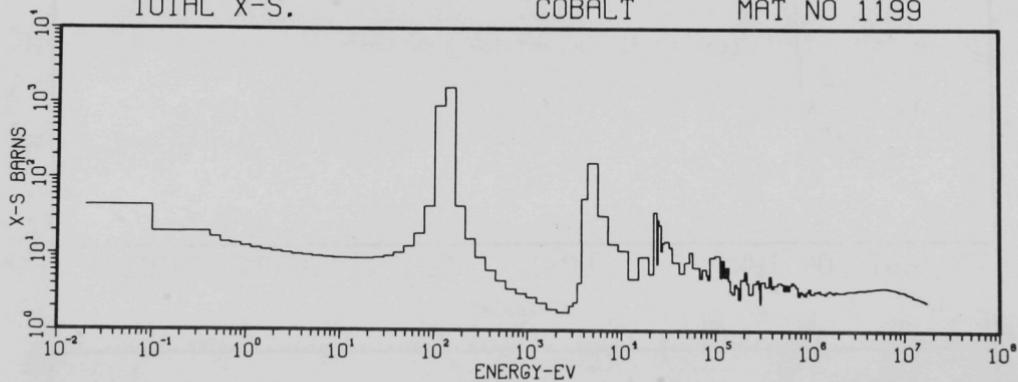
MAT NO 1192



TOTAL X-S.

COBALT

MAT NO 1199

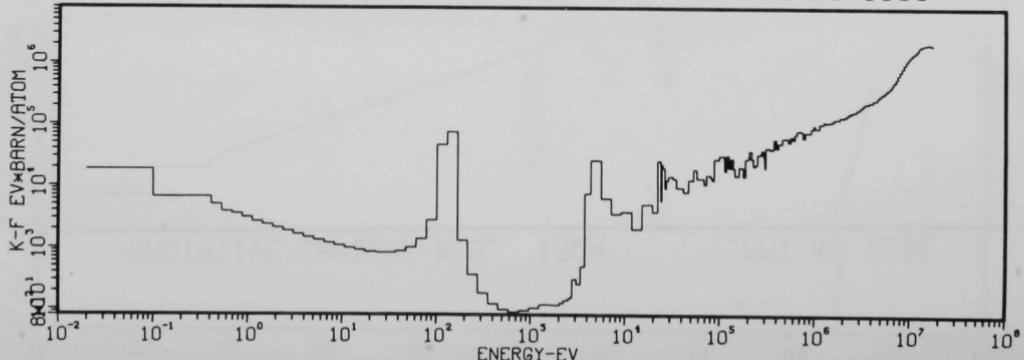


A
89-63

NEUTRON KERMA FACTOR

COBALT

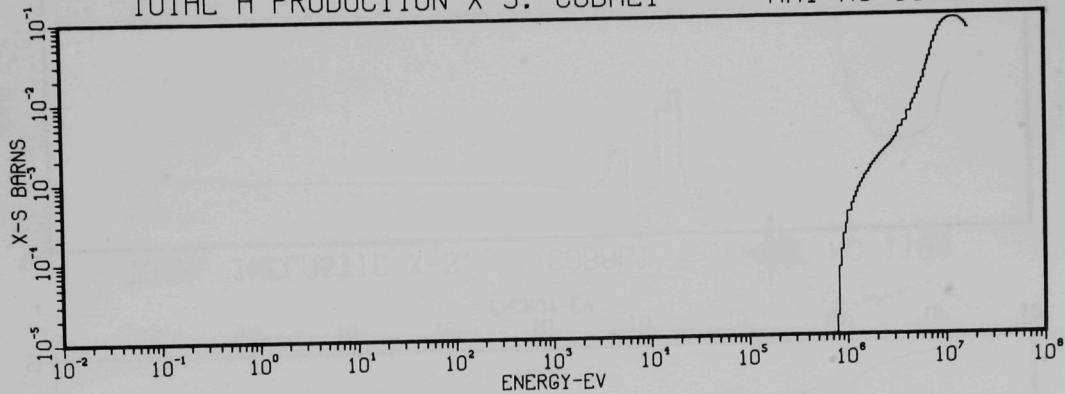
MAT NO 1199



4-69

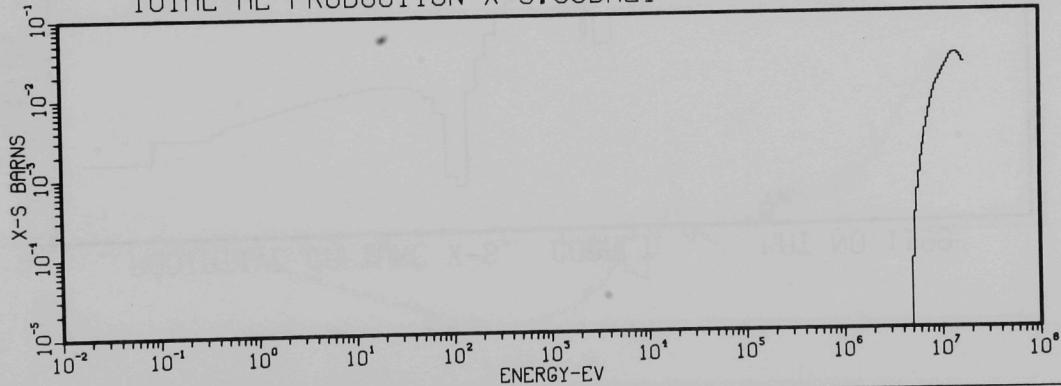
TOTAL H PRODUCTION X-S. COBALT

MAT NO 1199



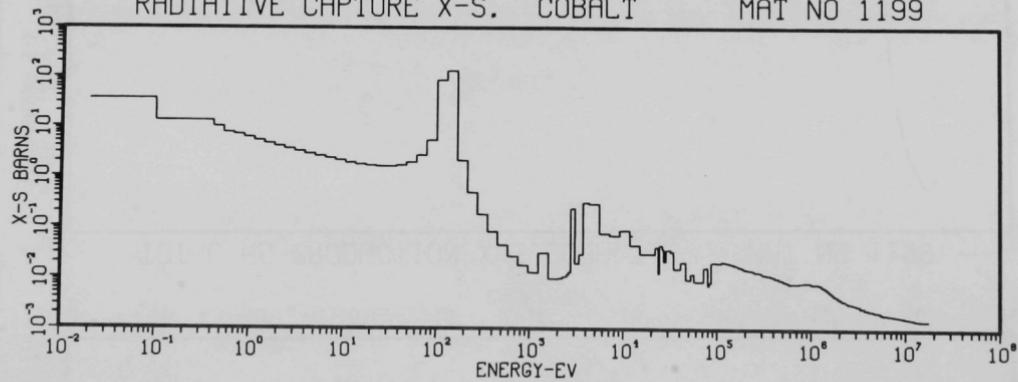
TOTAL HE PRODUCTION X-S.COBALT

MAT NO 1199



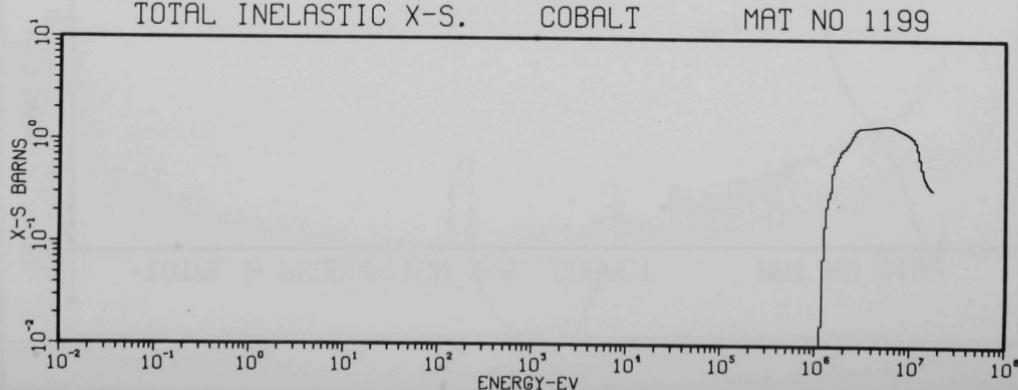
RADIATIVE CAPTURE X-S. COBALT

MAT NO 1199



TOTAL INELASTIC X-S. COBALT

MAT NO 1199

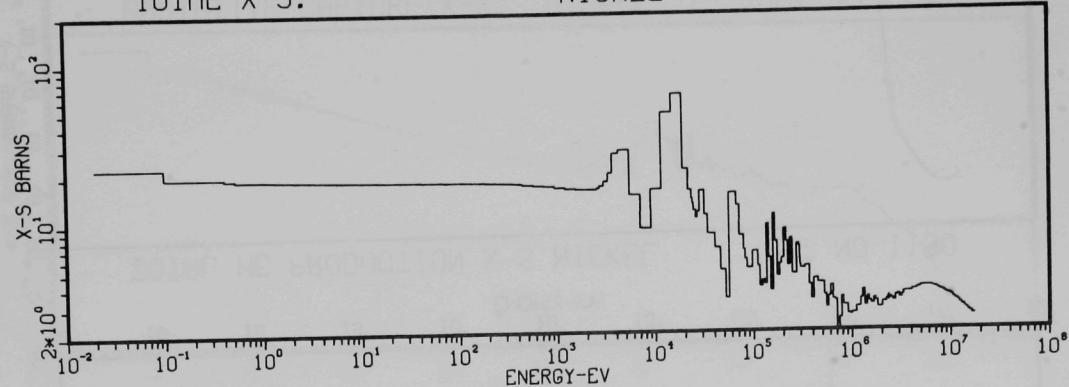


A-77

TOTAL X-S.

NICKEL

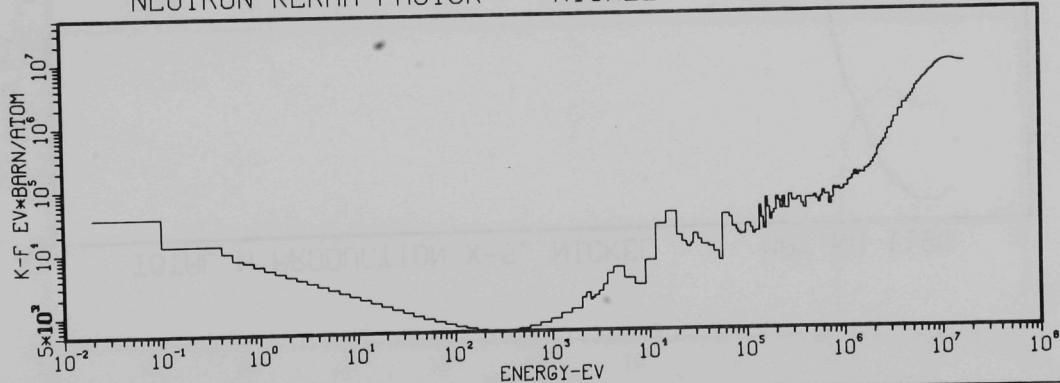
MAT NO 1190



NEUTRON KERMA FACTOR

NICKEL

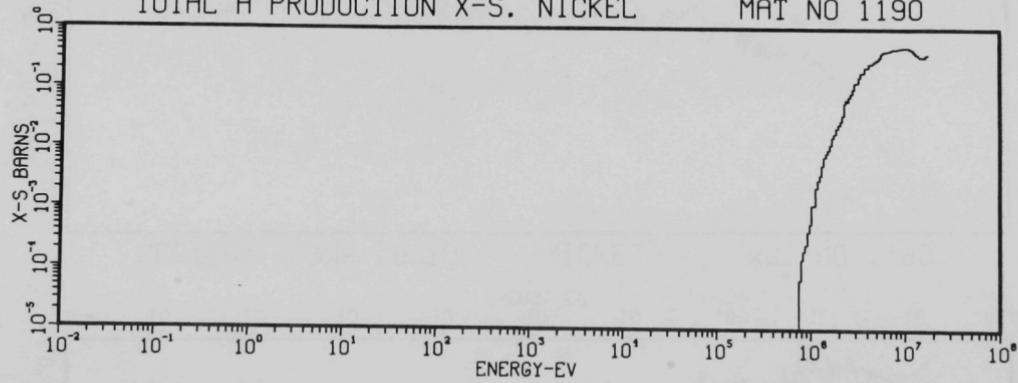
MAT NO 1190



A-72

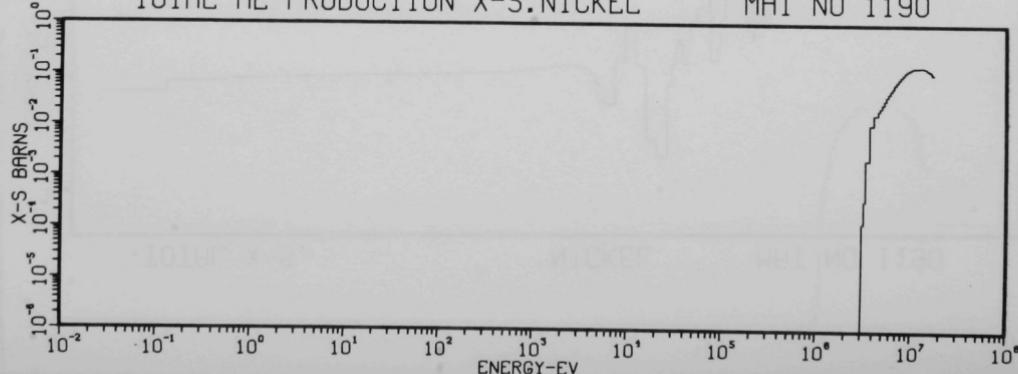
TOTAL H PRODUCTION X-S. NICKEL

MAT NO 1190

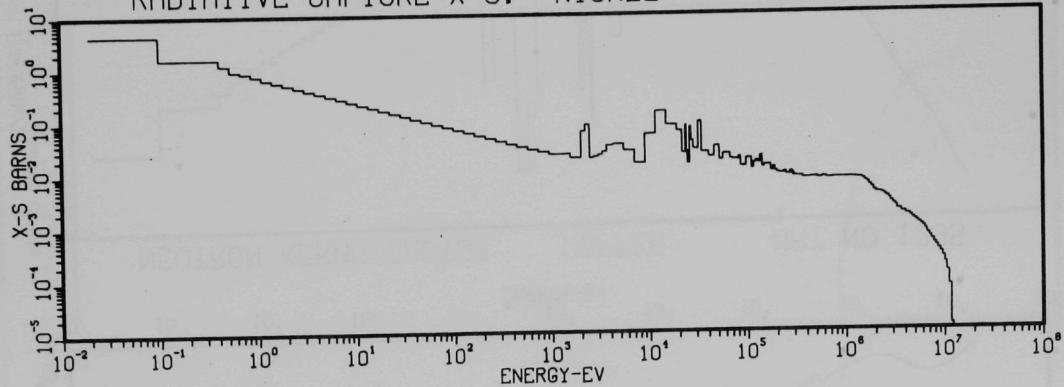


TOTAL HE PRODUCTION X-S.NICKEL

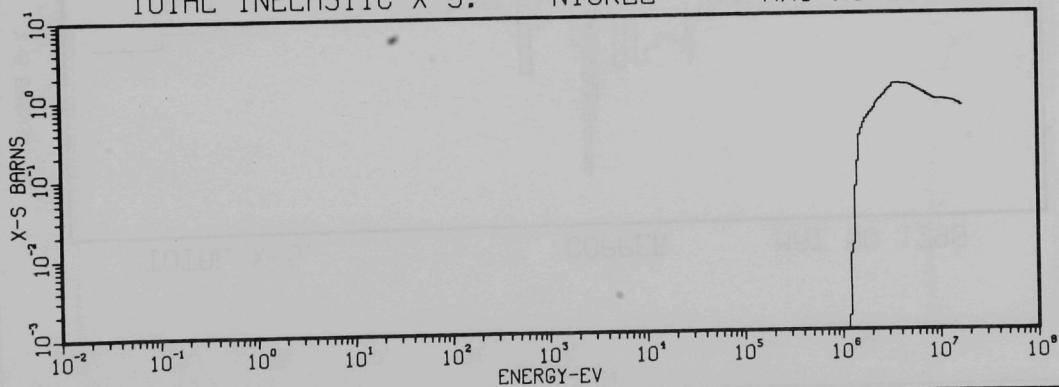
MAT NO 1190



RADIATIVE CAPTURE X-S. NICKEL MAT NO 1190



TOTAL INELASTIC X-S. NICKEL MAT NO 1190



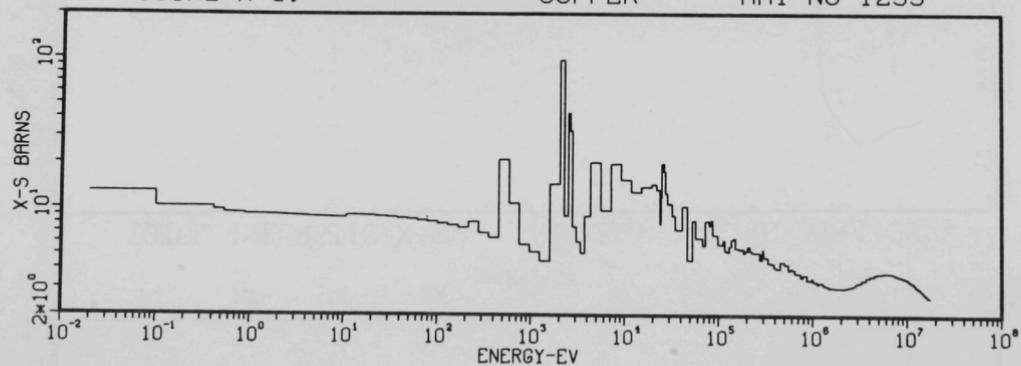
A-73

A-74

TOTAL X-S.

COPPER

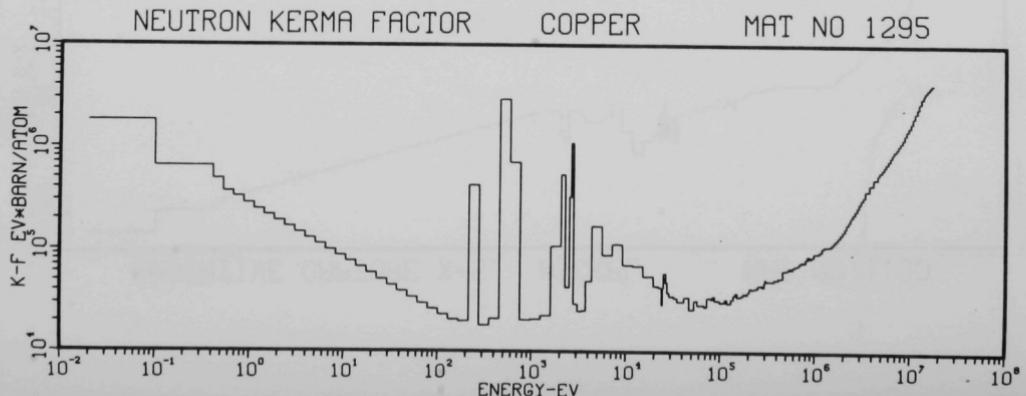
MAT NO 1295



NEUTRON KERMA FACTOR

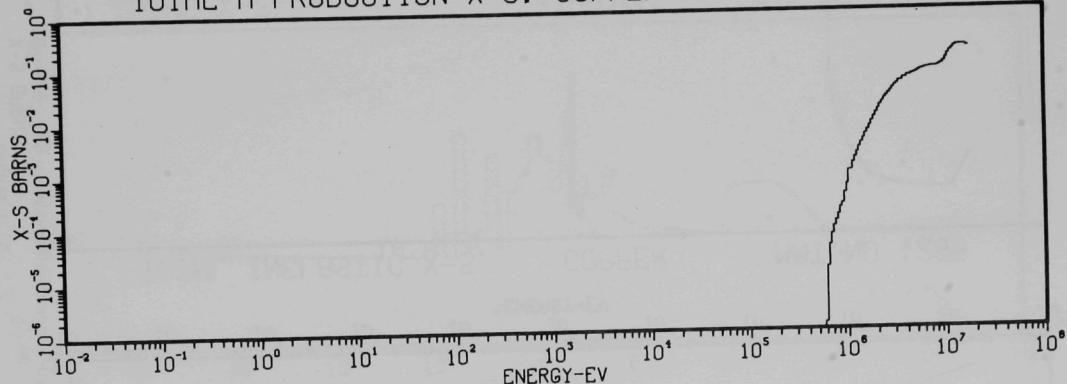
COPPER

MAT NO 1295



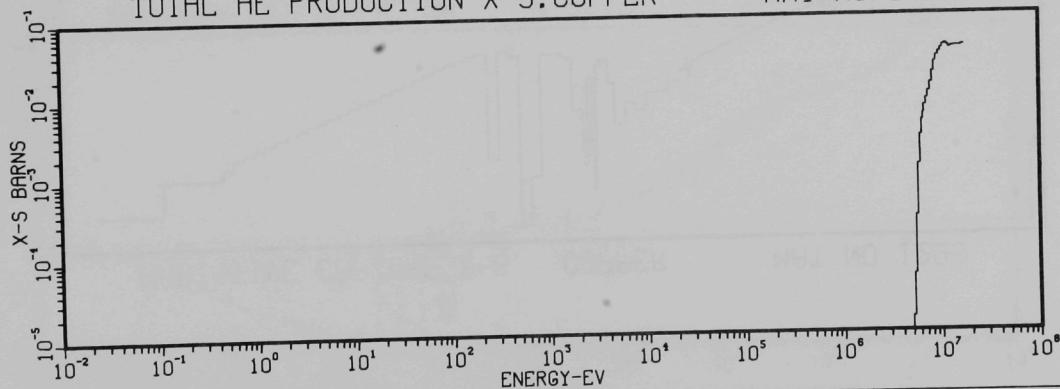
TOTAL H PRODUCTION X-S. COPPER

MAT NO 1295



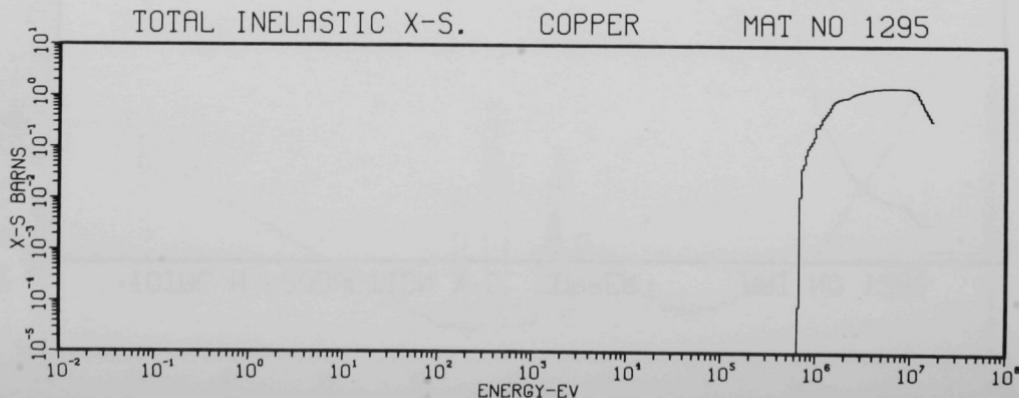
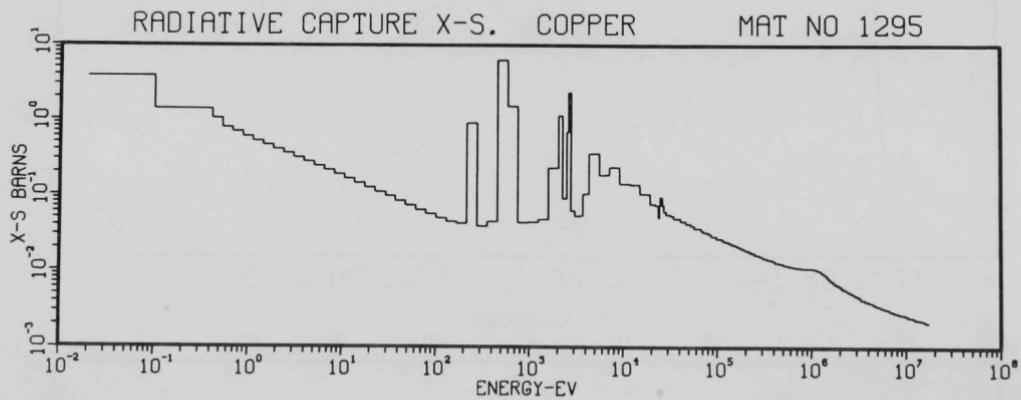
TOTAL HE PRODUCTION X-S.COPPER

MAT NO 1295



A-75

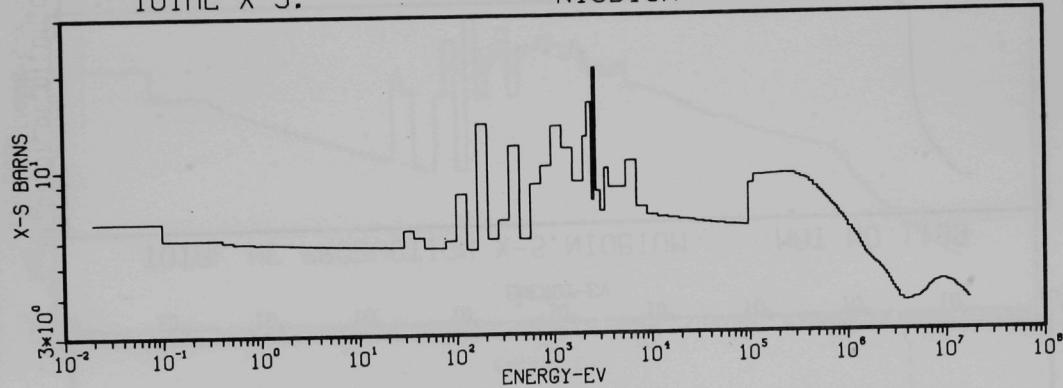
476



TOTAL X-S.

NIOBIUM

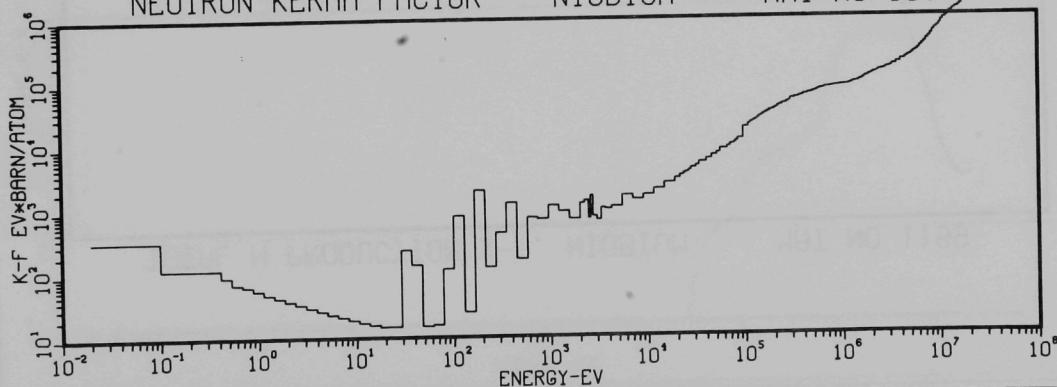
MAT NO 1189



NEUTRON KERMA FACTOR

NIOBIUM

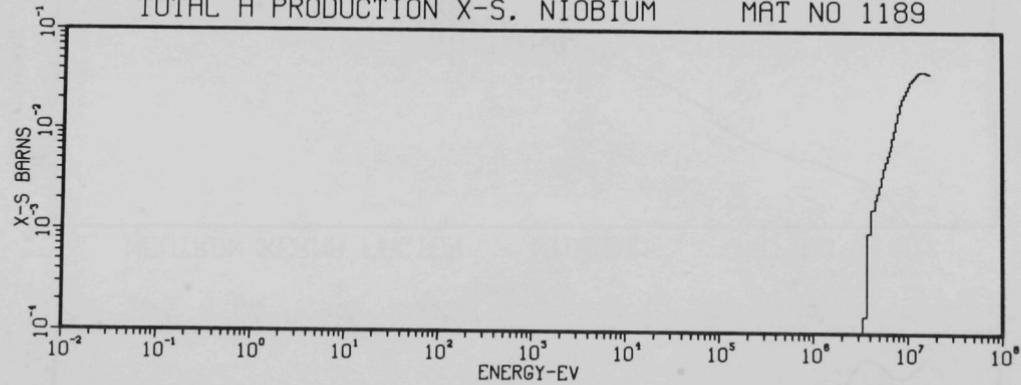
MAT NO 1189



878

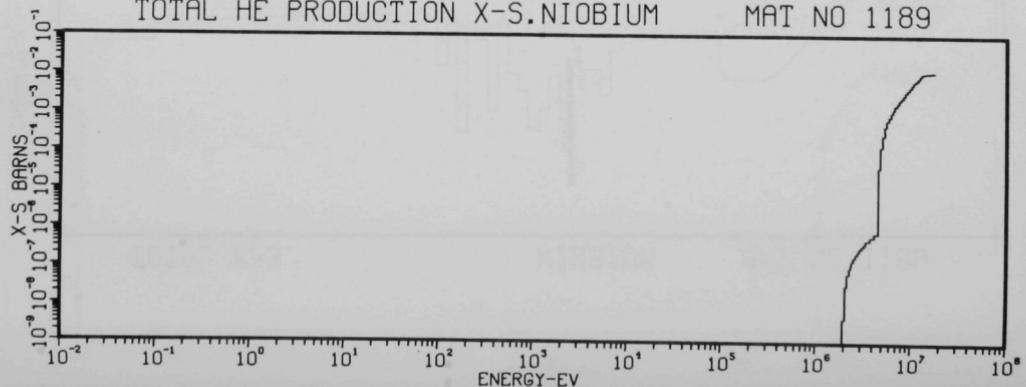
TOTAL H PRODUCTION X-S. NIOBIUM

MAT NO 1189

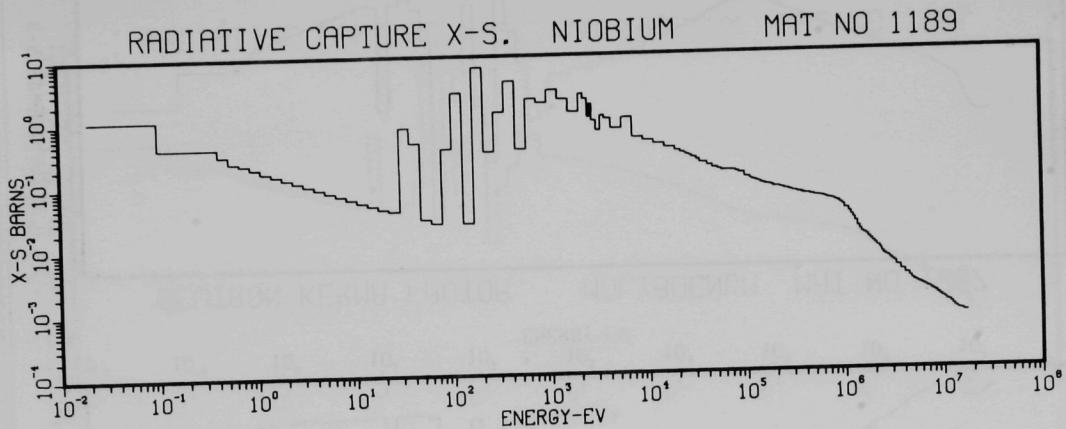


TOTAL HE PRODUCTION X-S.NIOBIUM

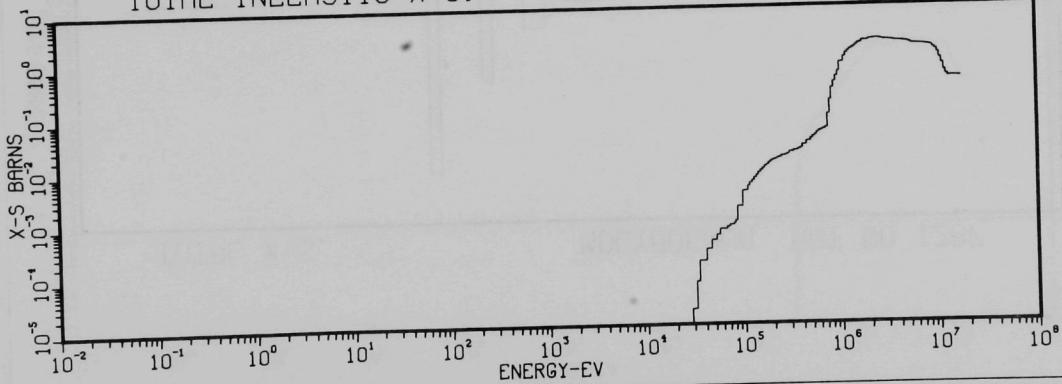
MAT NO 1189



67-V



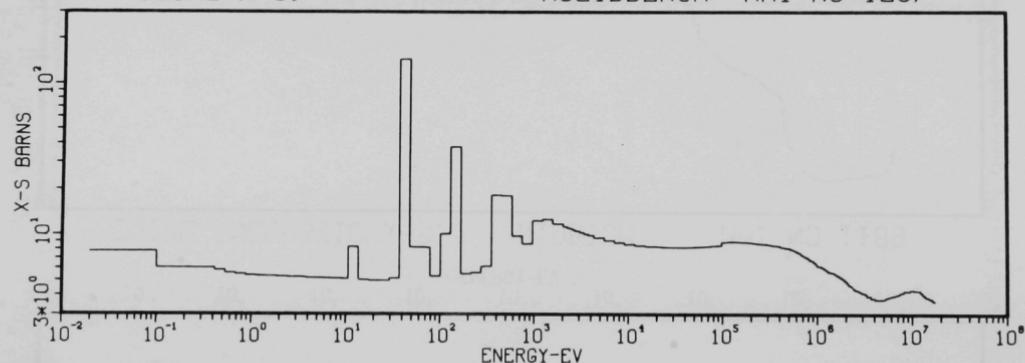
TOTAL INELASTIC X-S. NIOBIUM MAT NO 1189



6-30

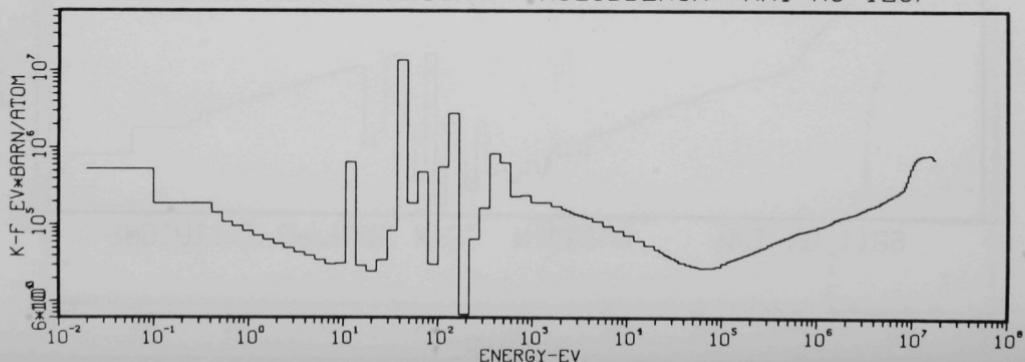
TOTAL X-S.

MOLYBDENUM MAT NO 1287

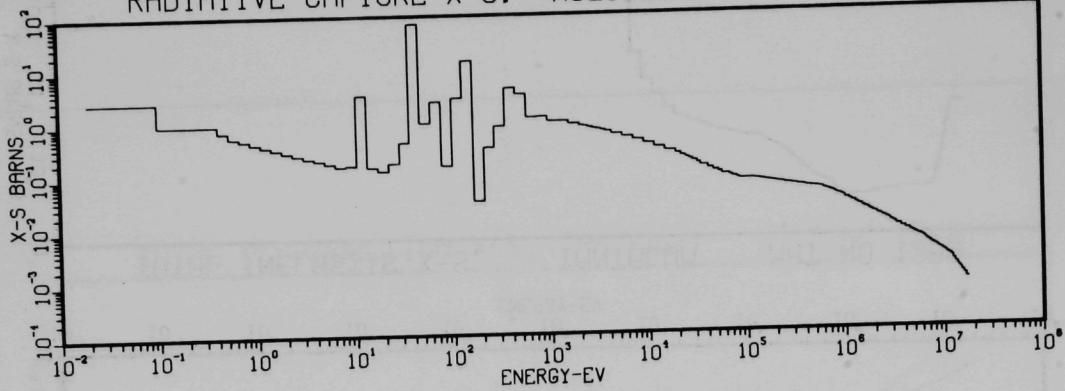


NEUTRON KERMA FACTOR

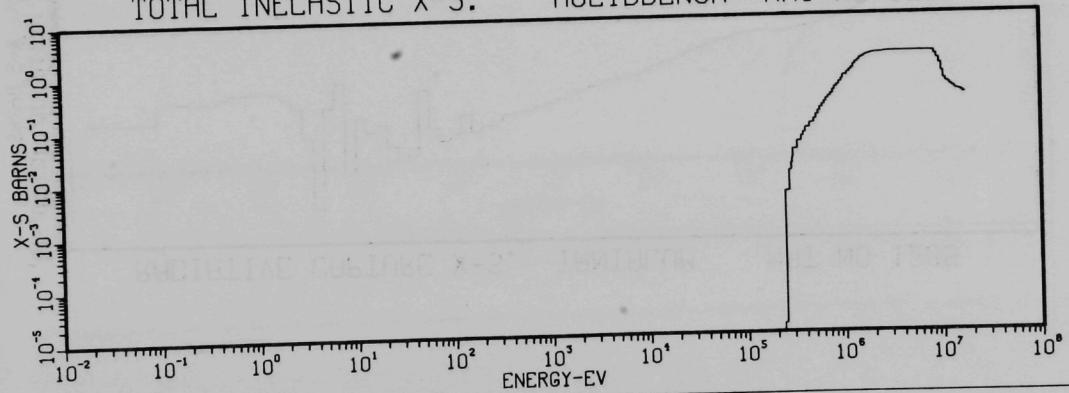
MOLYBDENUM MAT NO 1287



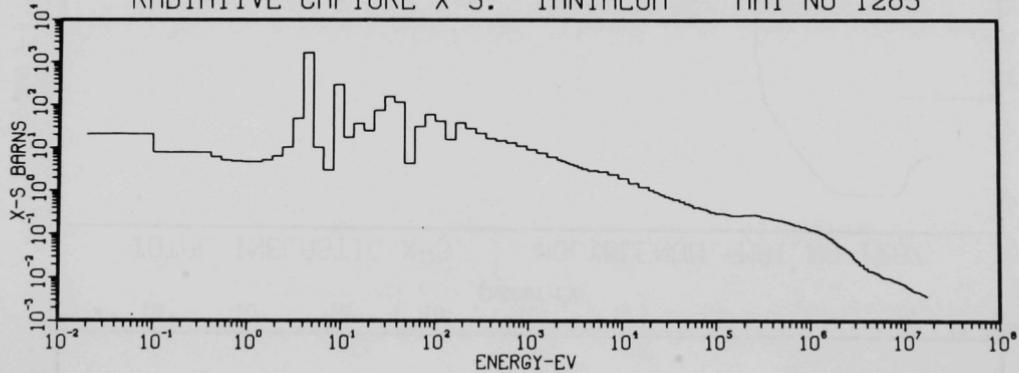
RADIATIVE CAPTURE X-S. MOLYBDENUM MAT NO 1287



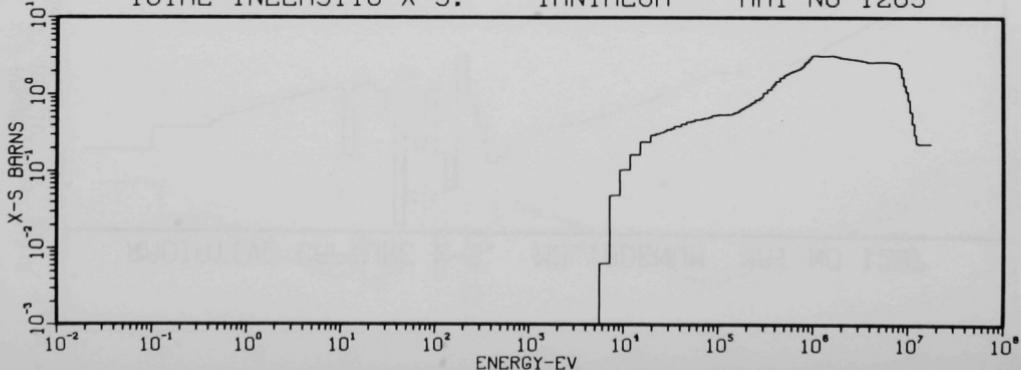
TOTAL INELASTIC X-S. MOLYBDENUM MAT NO 1287



RADIATIVE CAPTURE X-S. TANTALUM MAT NO 1285

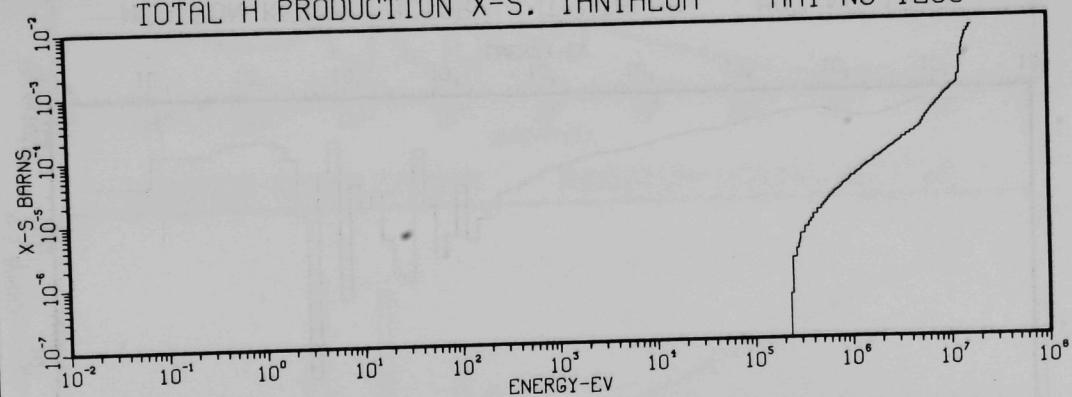


TOTAL INELASTIC X-S. TANTALUM MAT NO 1285



A-83

TOTAL H PRODUCTION X-S. TANTALUM MAT NO 1285

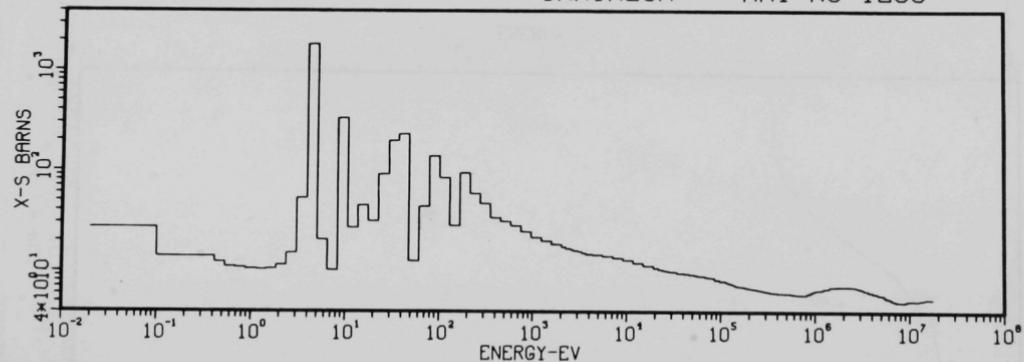


$\gamma\gamma\gamma^N$

TOTAL X-S.

TANTALUM

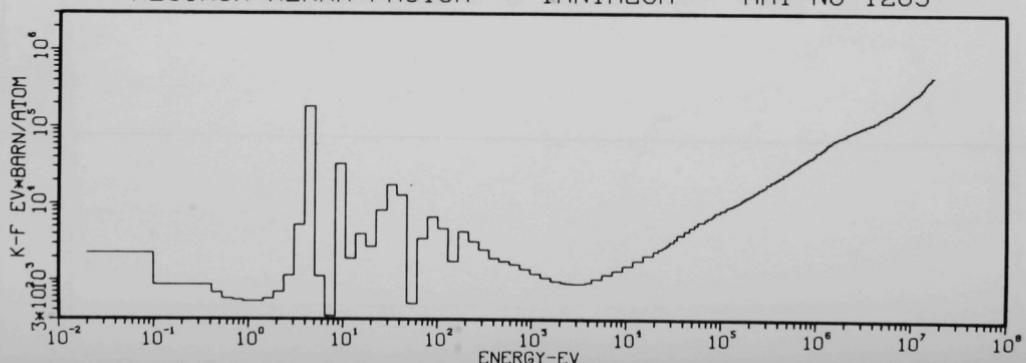
MAT NO 1285



NEUTRON KERMA FACTOR

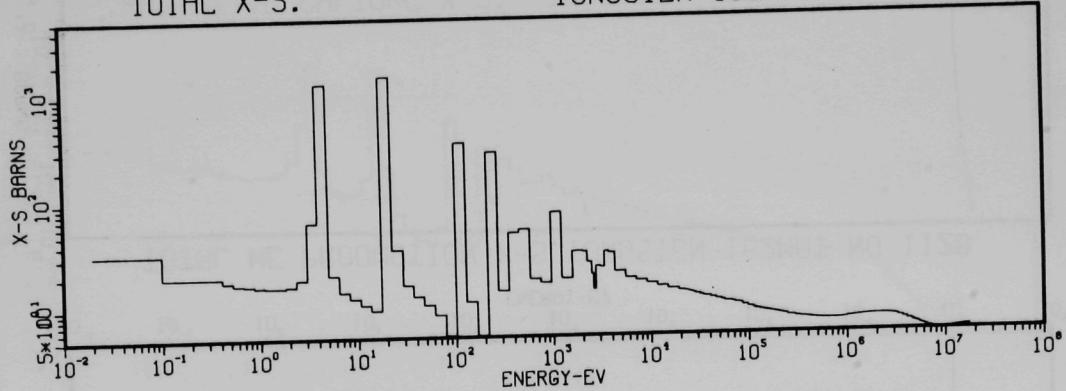
TANTALUM

MAT NO 1285



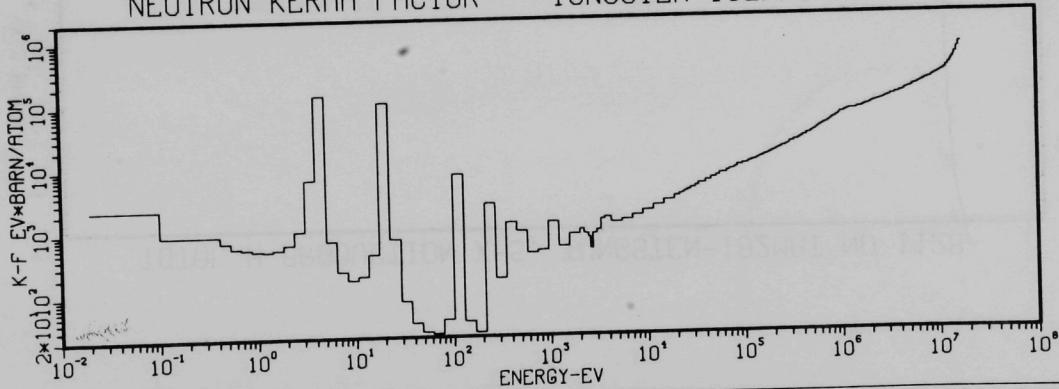
TOTAL X-S.

TUNGSTEN-182MAT NO 1128

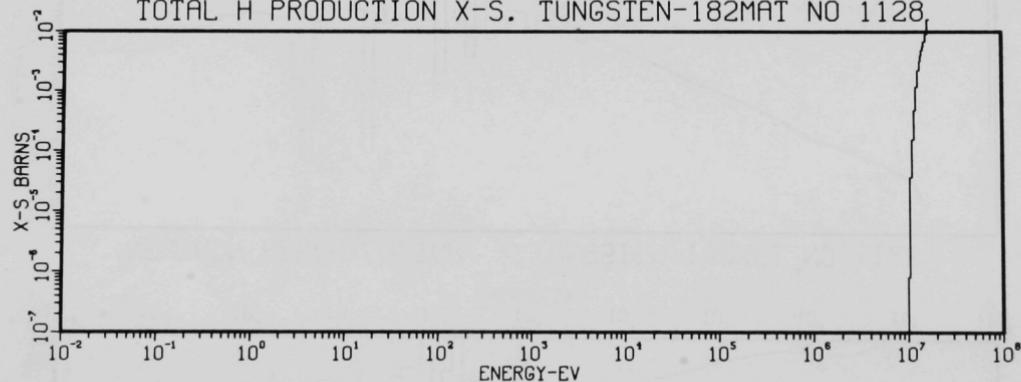


NEUTRON KERMA FACTOR

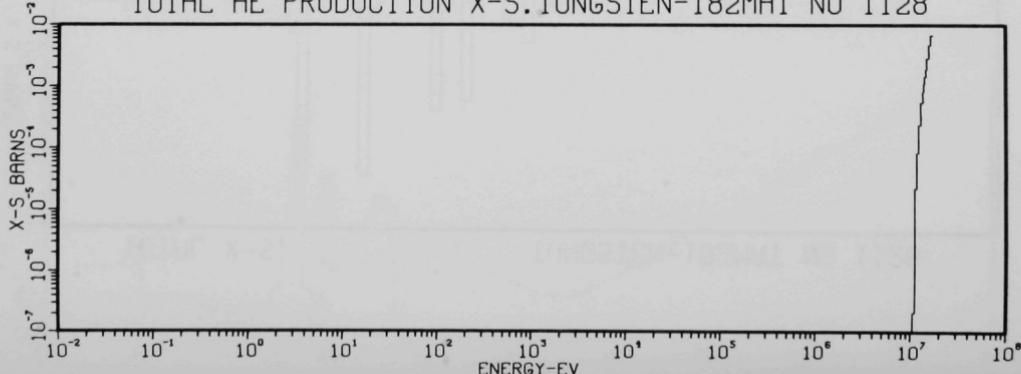
TUNGSTEN-182MAT NO 1128



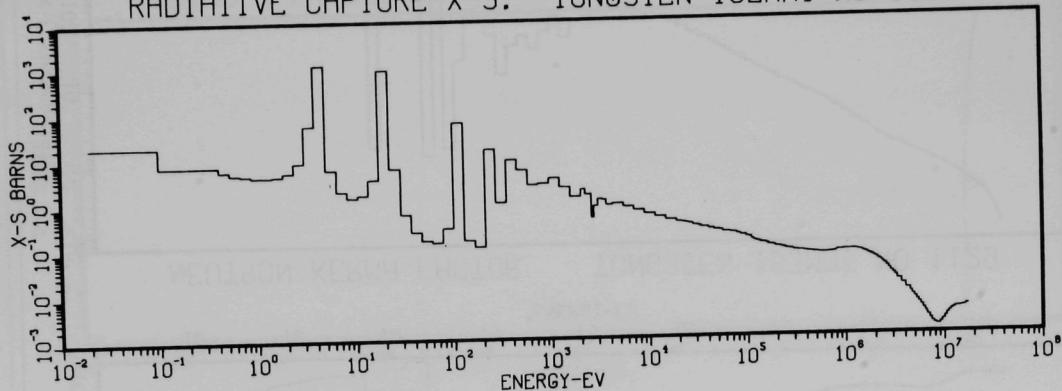
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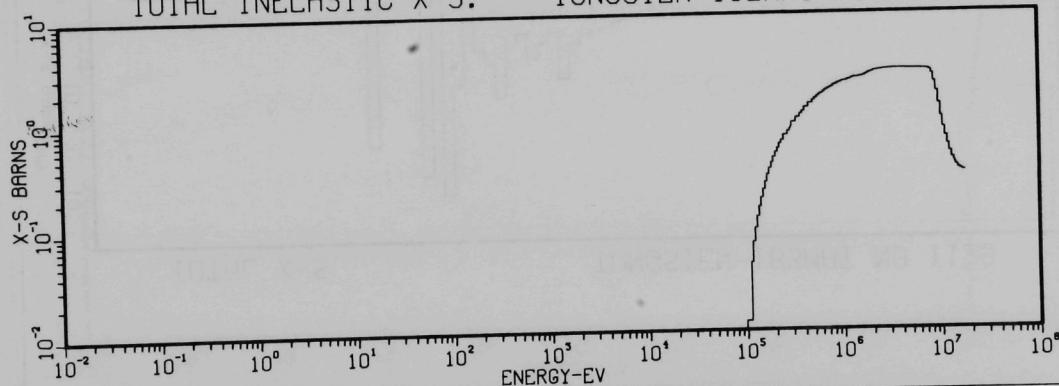
TOTAL HE PRODUCTION X-S.TUNGSTEN-182MAT NO 1128



RADIATIVE CAPTURE X-S. TUNGSTEN-182MAT NO 1128

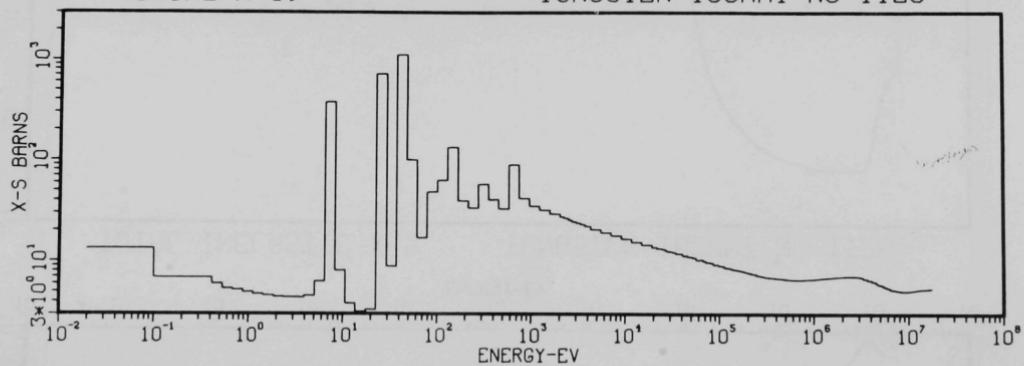


TOTAL INELASTIC X-S. TUNGSTEN-182MAT NO 1128



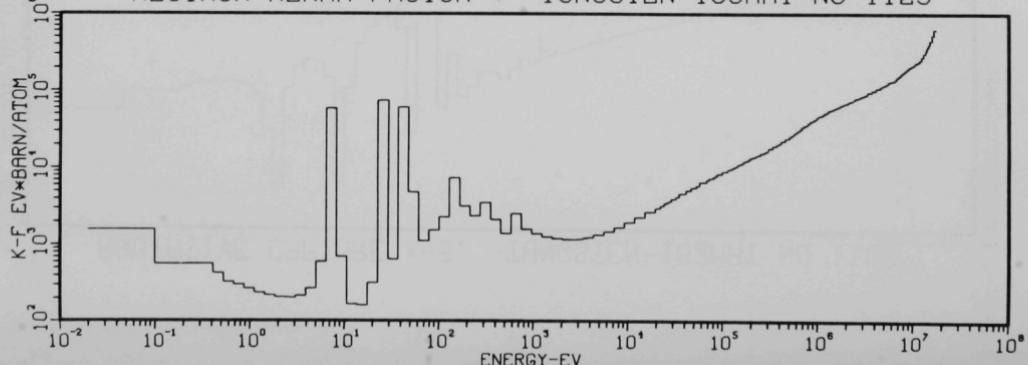
TOTAL X-S.

TUNGSTEN-183MAT NO 1129



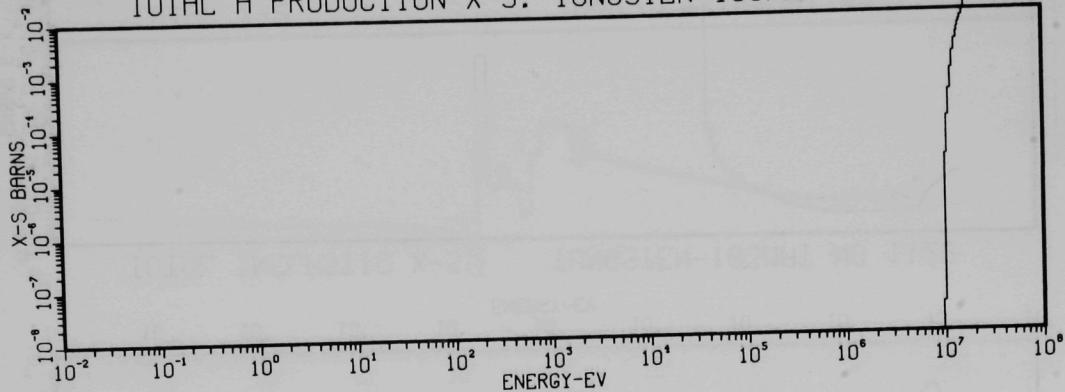
NEUTRON KERMA FACTOR

TUNGSTEN-183MAT NO 1129

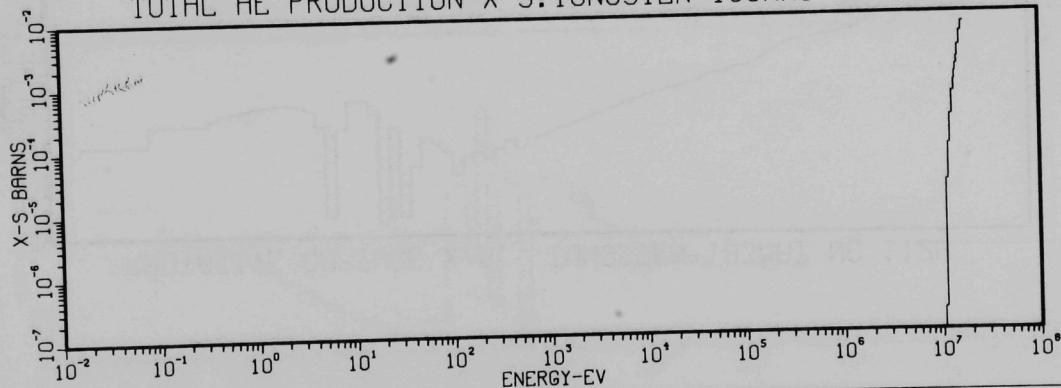


A-89

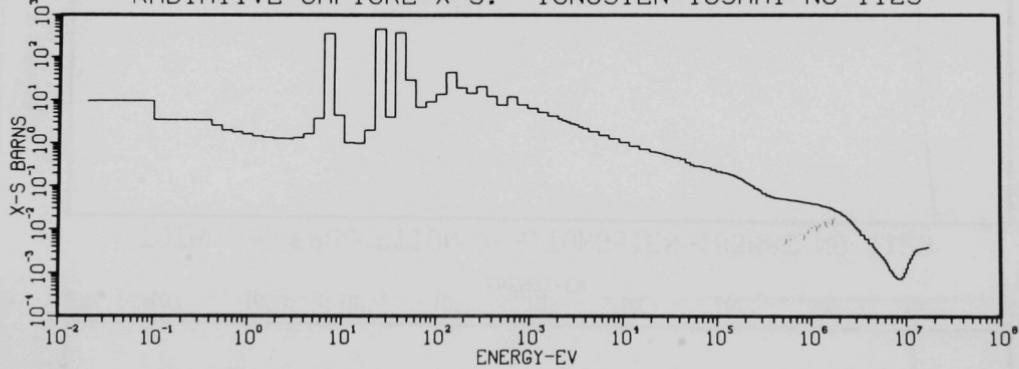
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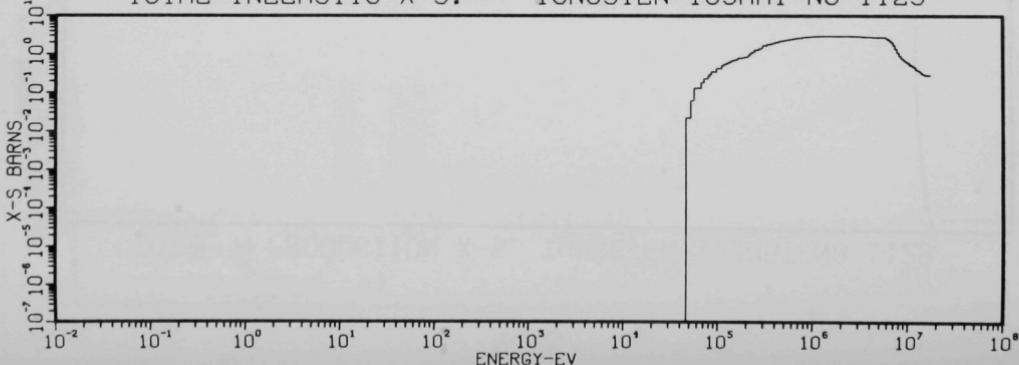
TOTAL HE PRODUCTION X-S.TUNGSTEN-183MAT NO 1129



RADIATIVE CAPTURE X-S. TUNGSTEN-183MAT NO 1129



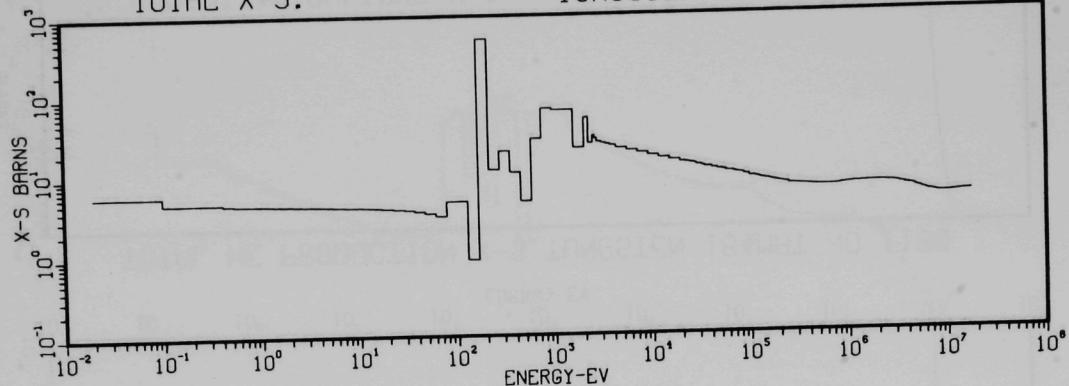
TOTAL INELASTIC X-S. TUNGSTEN-183MAT NO 1129



L6-V

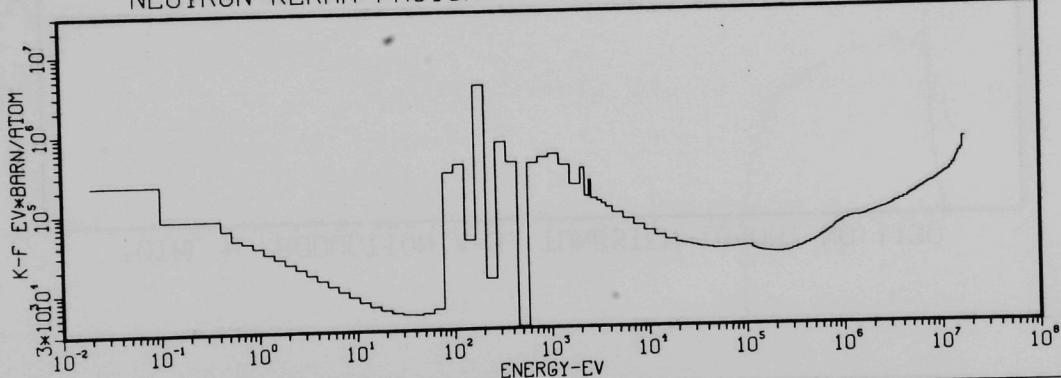
TOTAL X-S.

TUNGSTEN-184MAT NO 1130

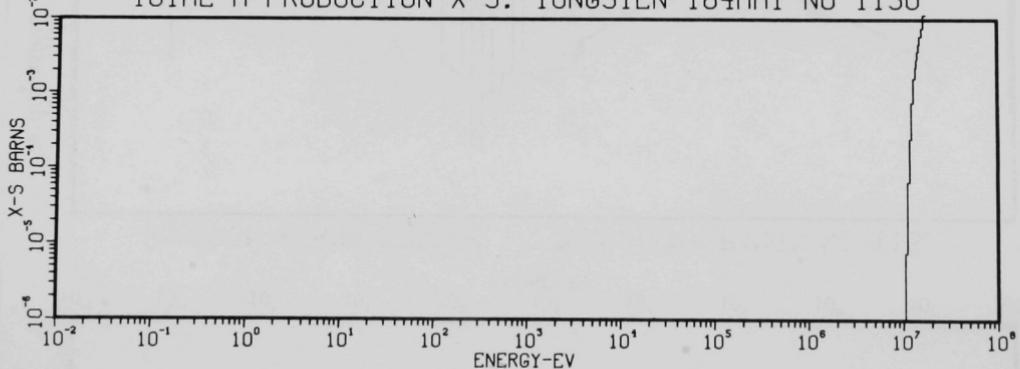


NEUTRON KERMA FACTOR

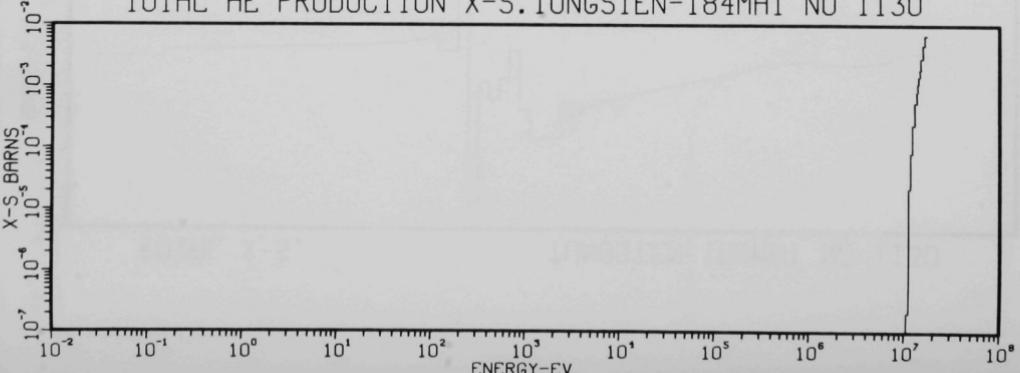
TUNGSTEN-184MAT NO 1130



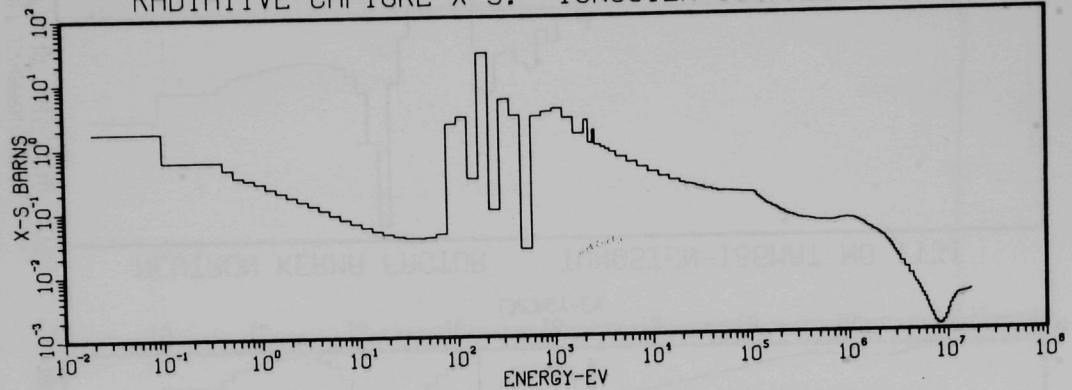
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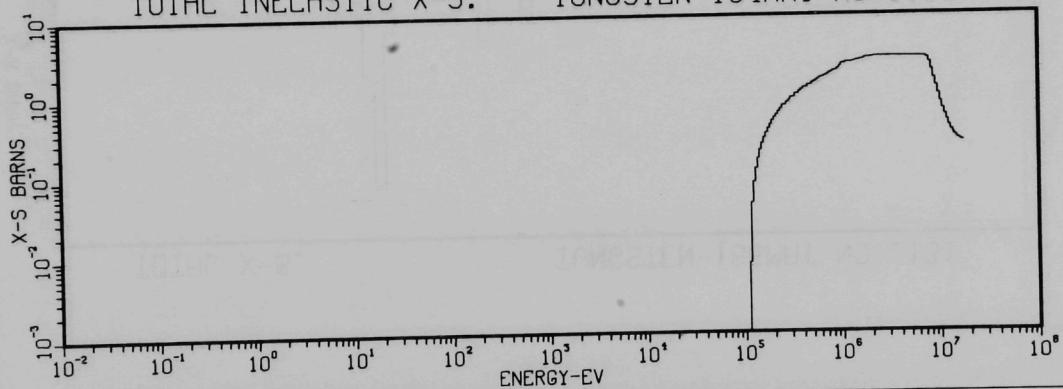
TOTAL HE PRODUCTION X-S.TUNGSTEN-184MAT NO 1130



RADIATIVE CAPTURE X-S. TUNGSTEN-184MAT NO 1130

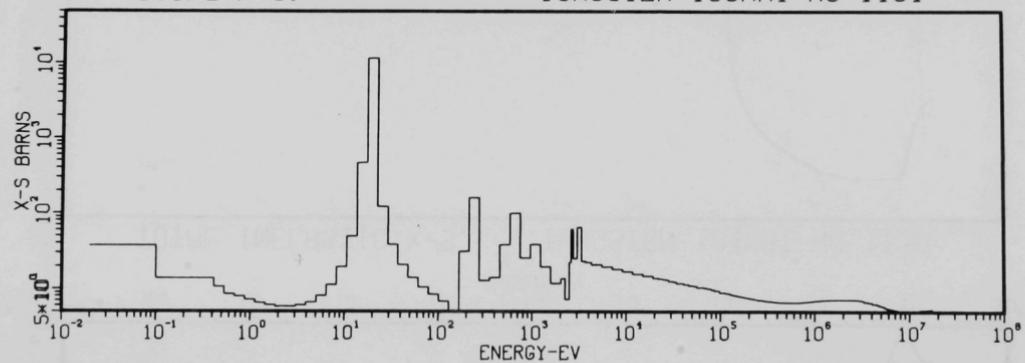


TOTAL INELASTIC X-S. TUNGSTEN-184MAT NO 1130



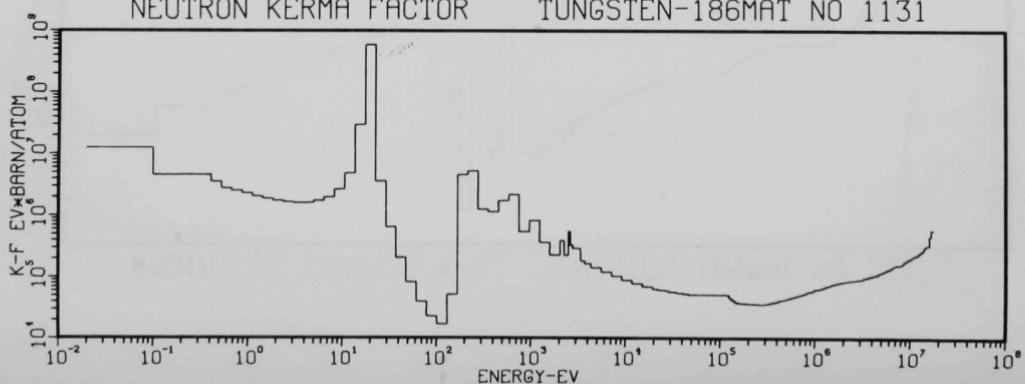
TOTAL X-S.

TUNGSTEN-186MAT NO 1131



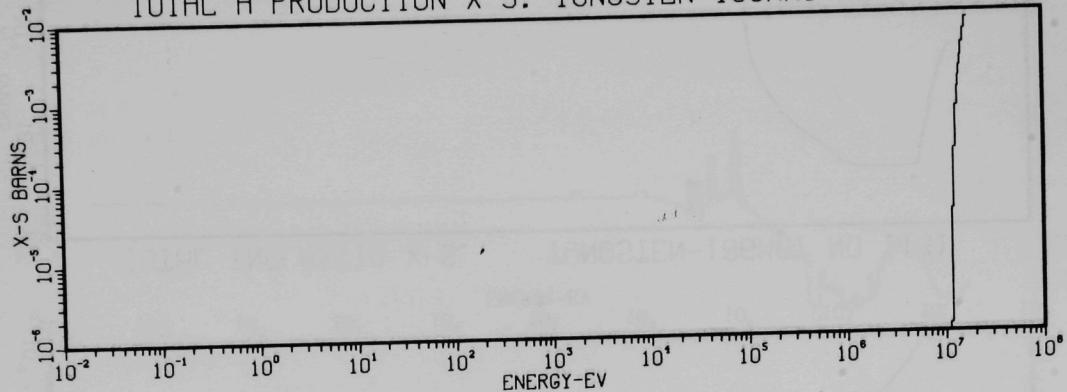
NEUTRON KERMA FACTOR

TUNGSTEN-186MAT NO 1131

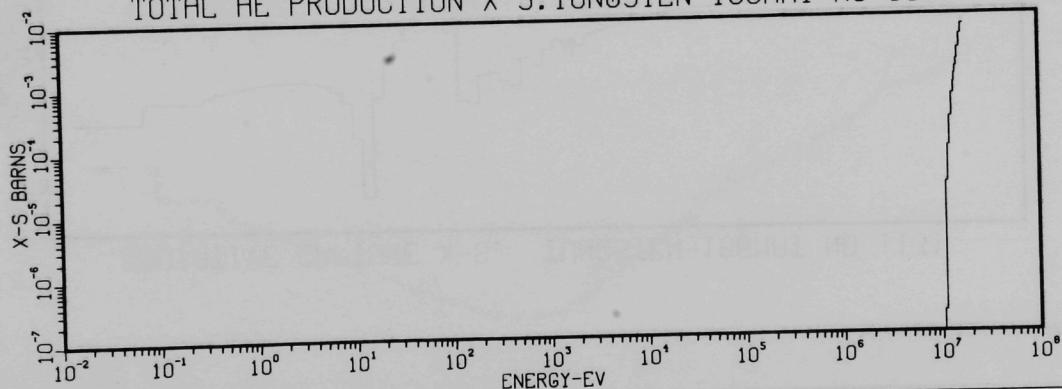


26-A

TOTAL H PRODUCTION X-S. TUNGSTEN-186MAT NO 1131

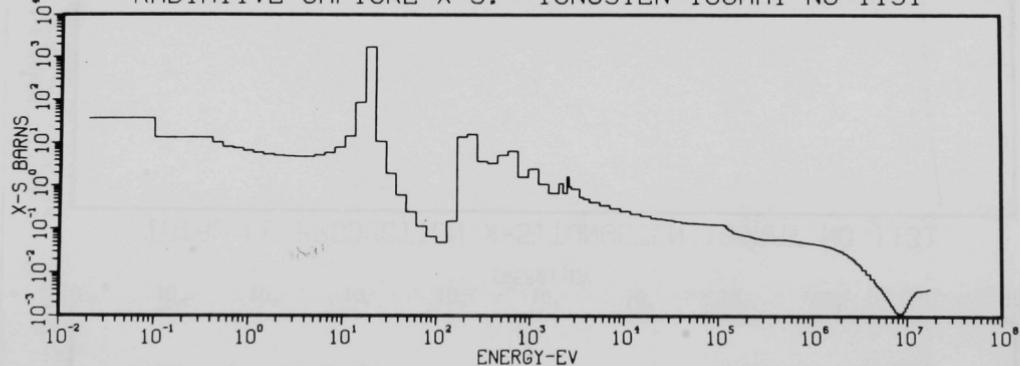


TOTAL HE PRODUCTION X-S.TUNGSTEN-186MAT NO 1131

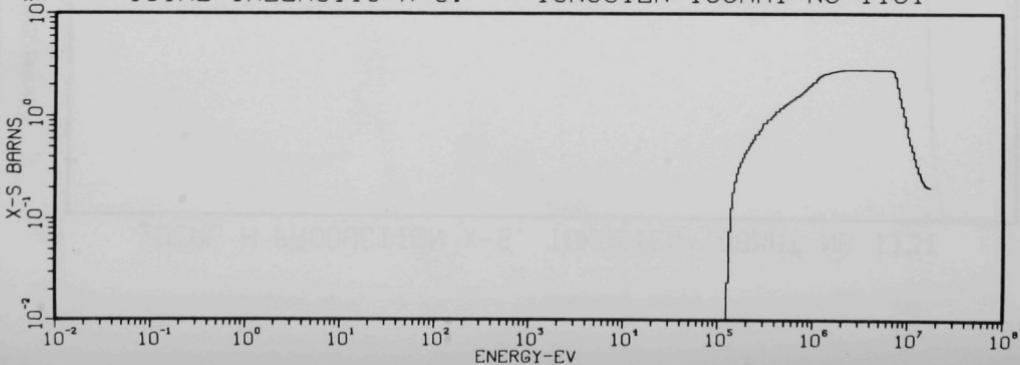


96-A

RADIATIVE CAPTURE X-S. TUNGSTEN-186MAT NO 1131



TOTAL INELASTIC X-S. TUNGSTEN-186MAT NO 1131

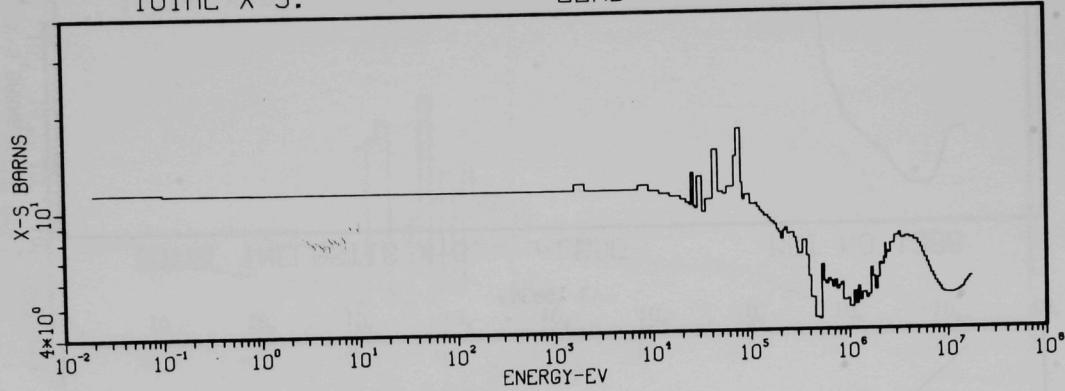


76-A

TOTAL X-S.

LEAD

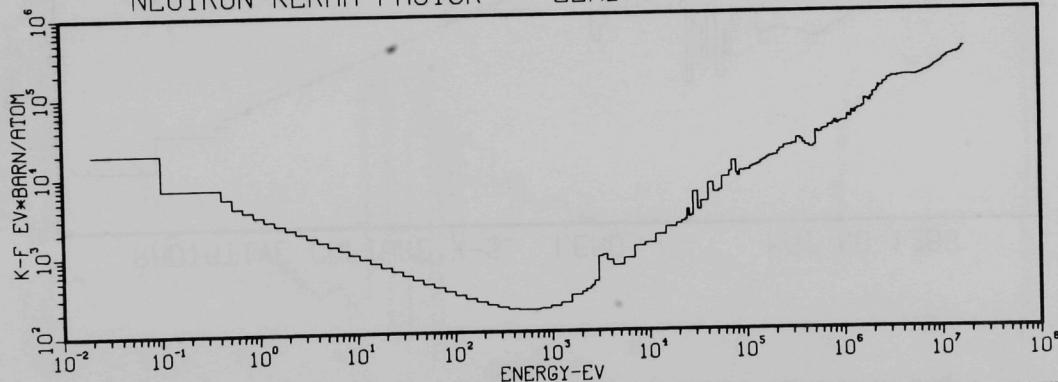
MAT NO 1288



NEUTRON KERMA FACTOR

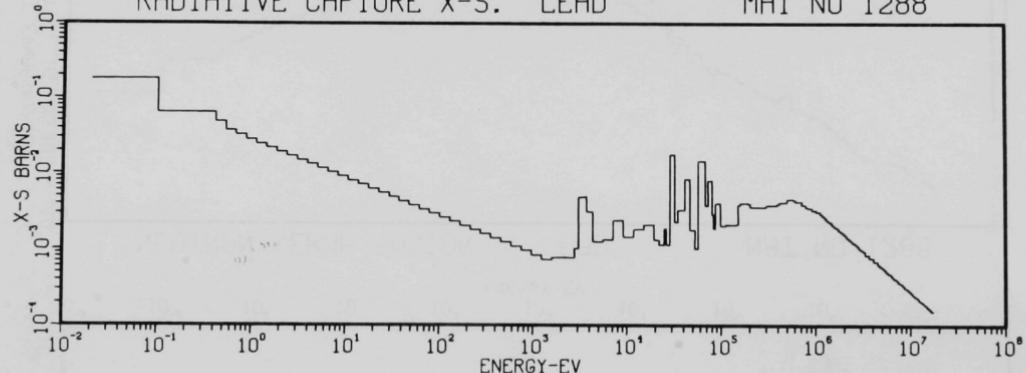
LEAD

MAT NO 1288



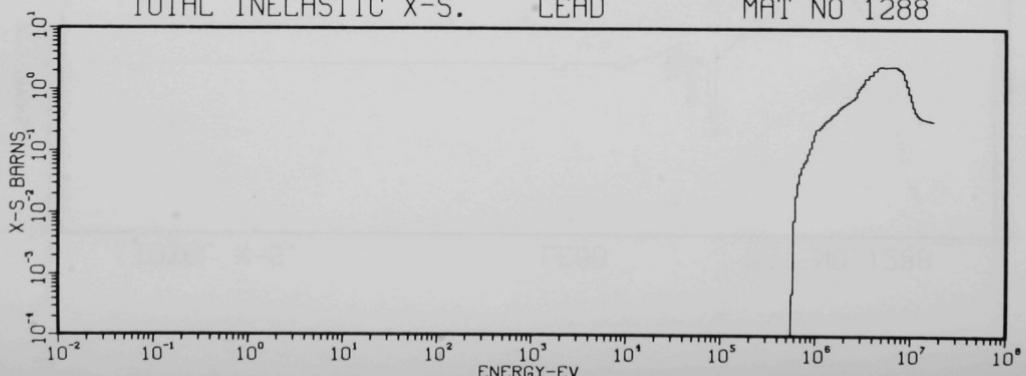
RADIATIVE CAPTURE X-S. LEAD

MAT NO 1288



TOTAL INELASTIC X-S. LEAD

MAT NO 1288

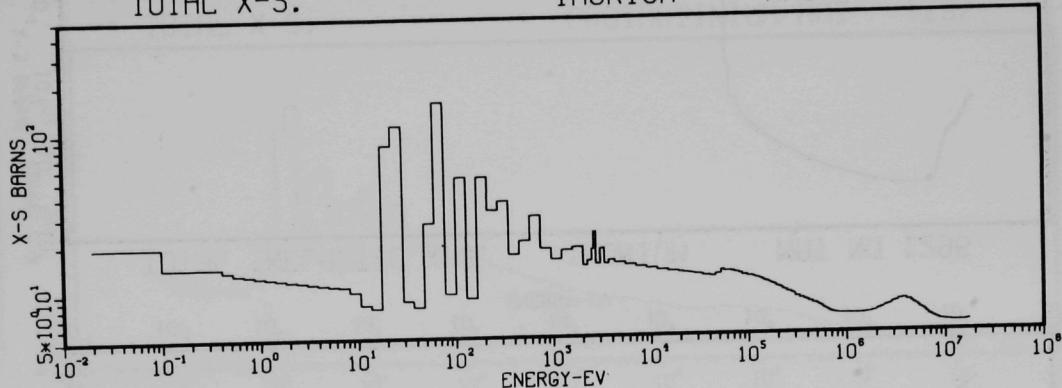


66-A

TOTAL X-S.

THORIUM

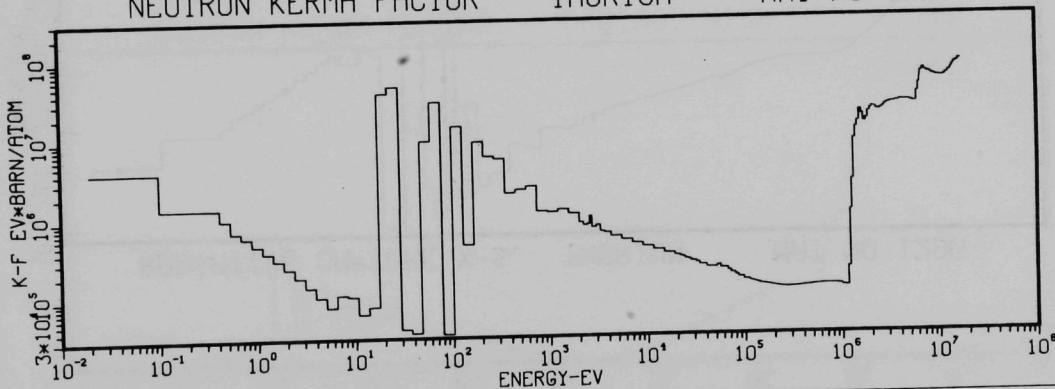
MAT NO 1296



NEUTRON KERMA FACTOR

THORIUM

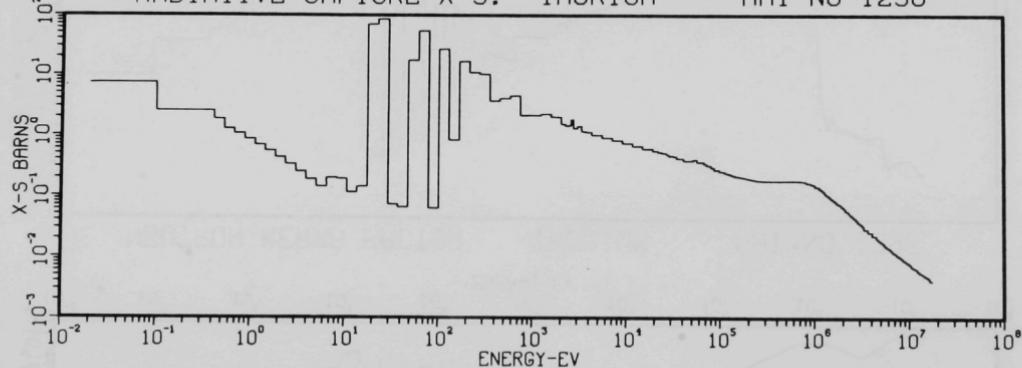
MAT NO 1296



A-100

RADIATIVE CAPTURE X-S. THORIUM

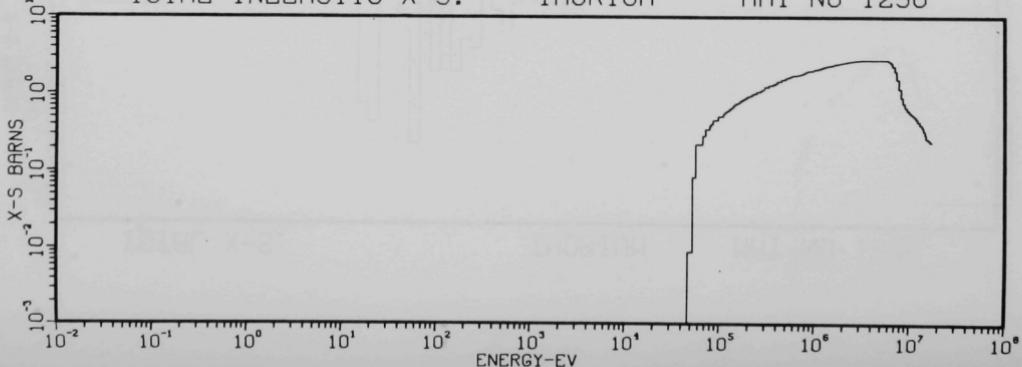
MAT NO 1296



TOTAL INELASTIC X-S.

THORIUM

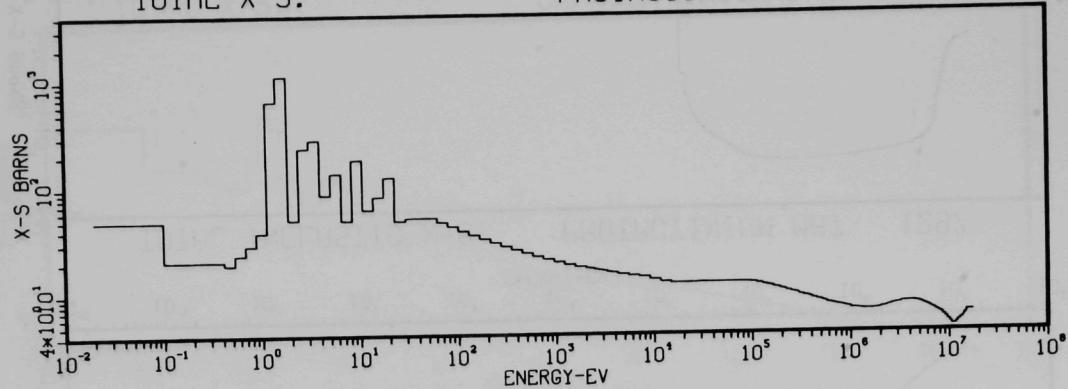
MAT NO 1296



TOTAL X-S.

PROTACTINIUM MAT

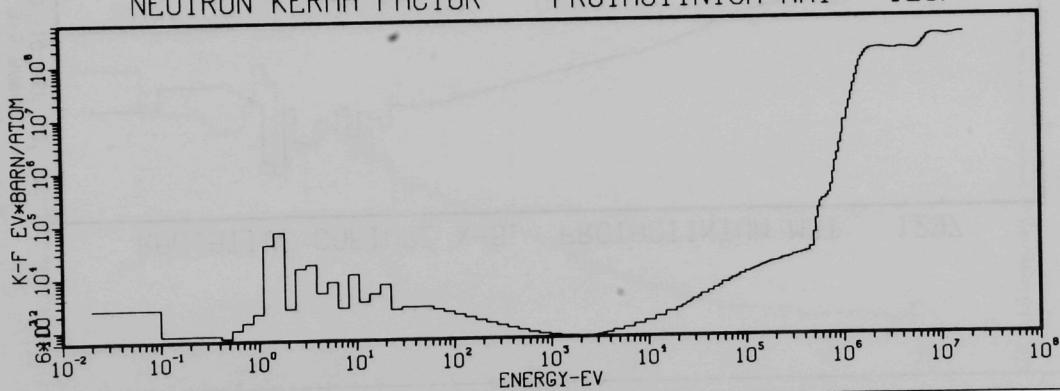
1297



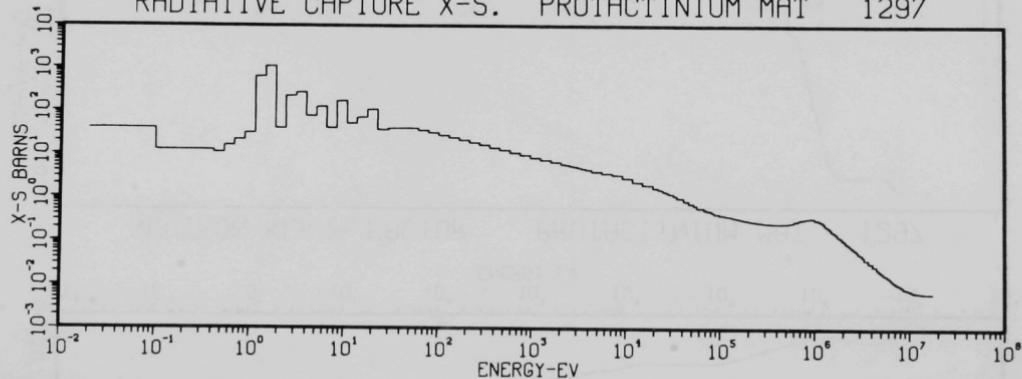
NEUTRON KERMA FACTOR

PROTACTINIUM MAT

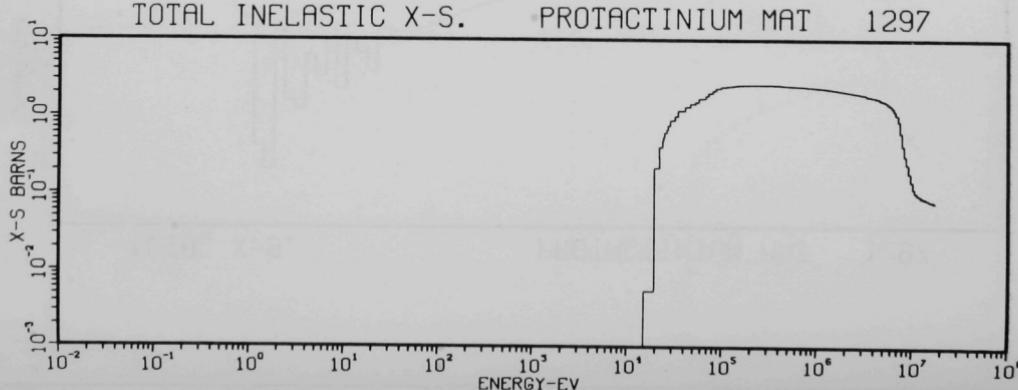
1297



RADIATIVE CAPTURE X-S. PROTACTINIUM MAT 1297

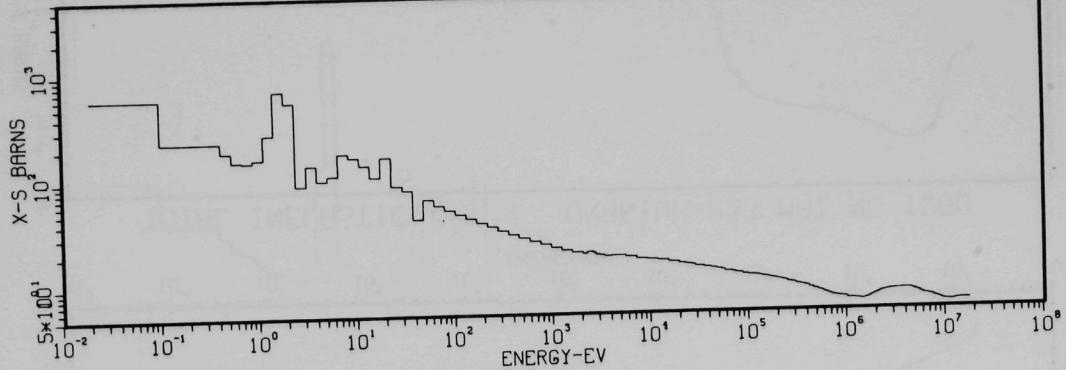


TOTAL INELASTIC X-S. PROTACTINIUM MAT 1297



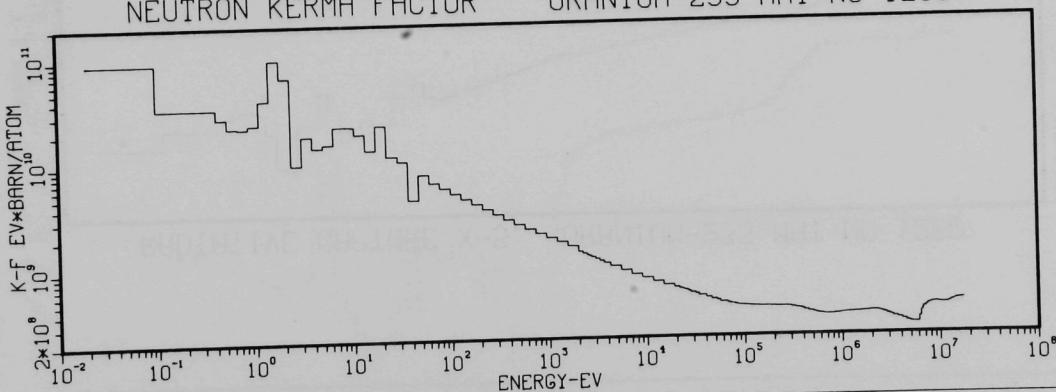
TOTAL X-S.

URANIUM-233 MAT NO 1260



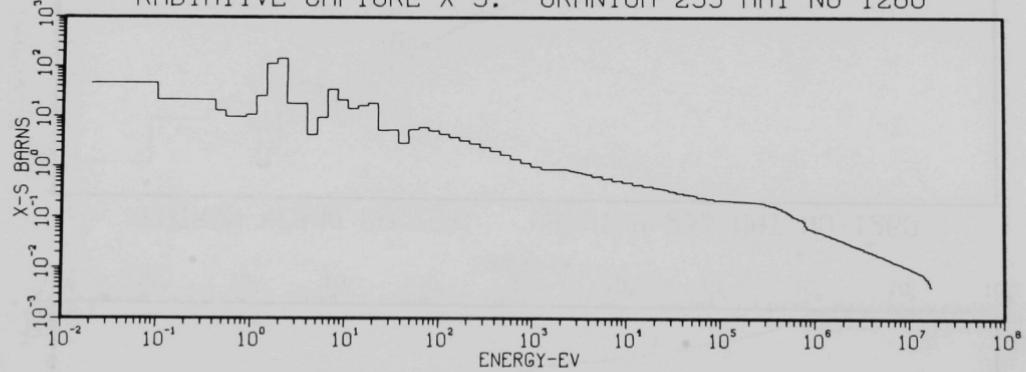
NEUTRON KERMA FACTOR

URANIUM-233 MAT NO 1260

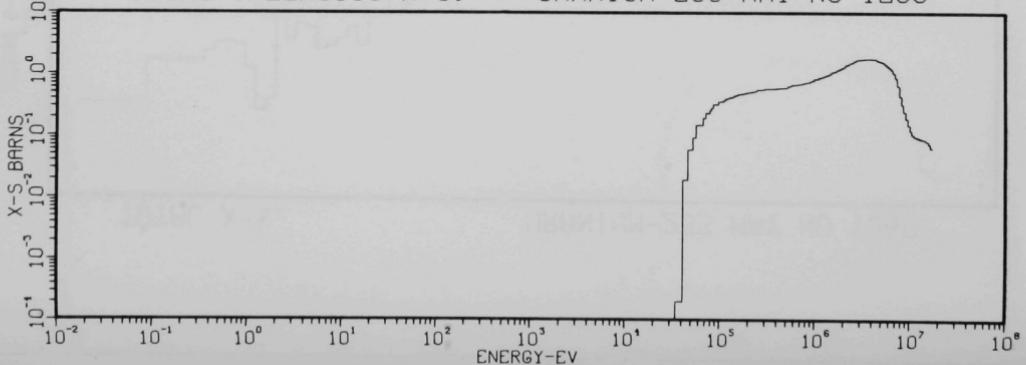


A-104

RADIATIVE CAPTURE X-S. URANIUM-233 MAT NO 1260



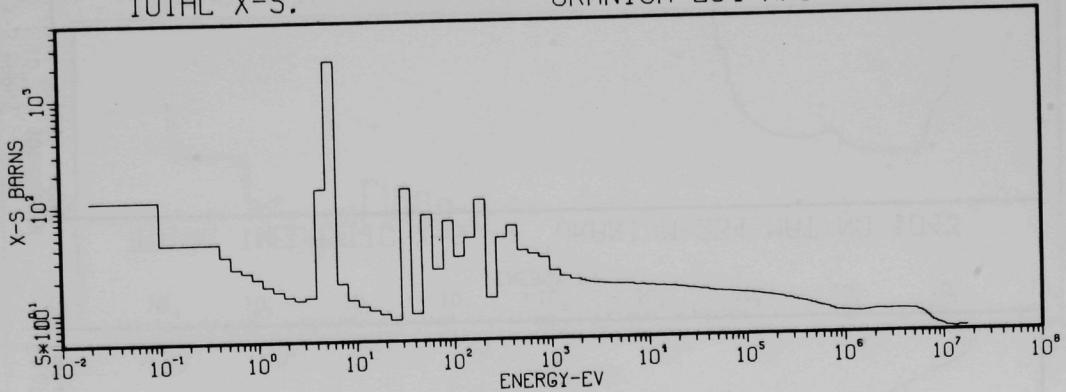
TOTAL INELASTIC X-S. URANIUM-233 MAT NO 1260



A-105

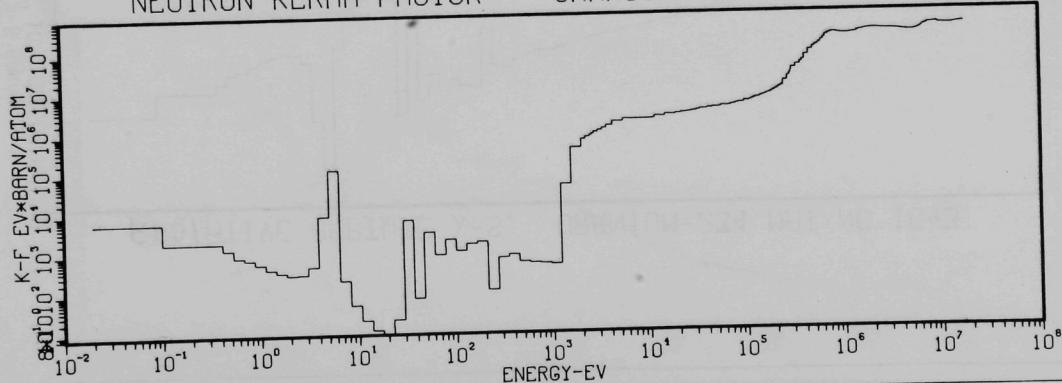
TOTAL X-S.

URANIUM-234 MAT NO 1043



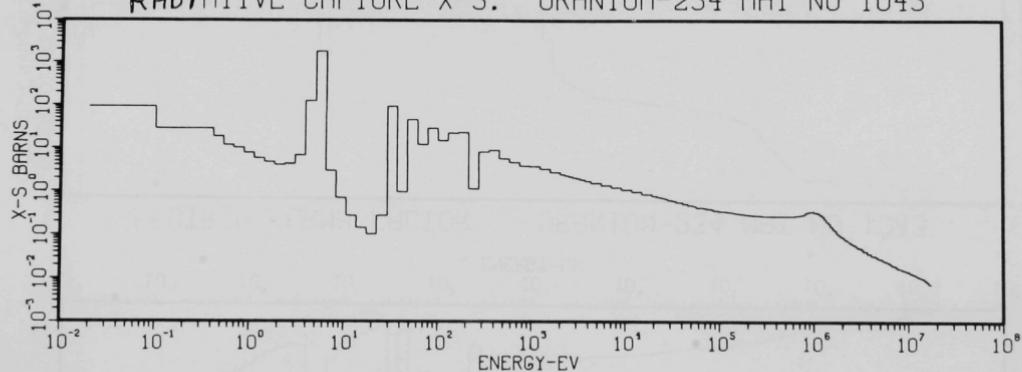
NEUTRON KERMA FACTOR

URANIUM-234 MAT NO 1043

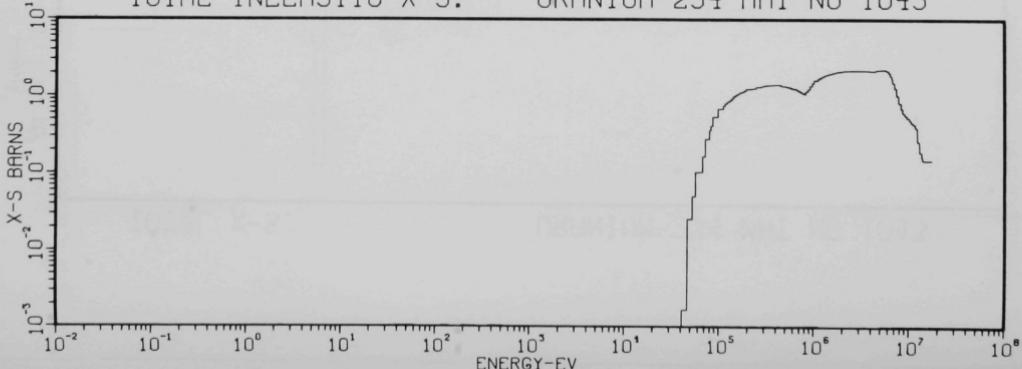


A-106

RADIATIVE CAPTURE X-S. URANIUM-234 MAT NO 1043



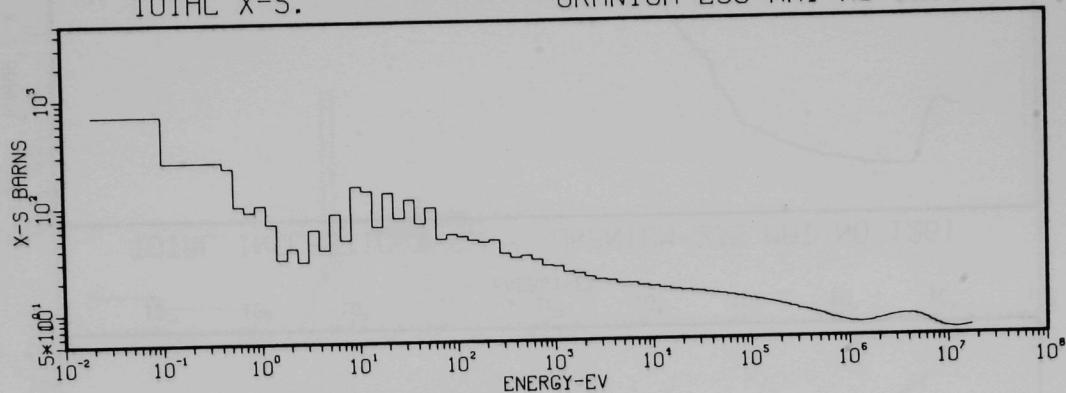
TOTAL INELASTIC X-S. URANIUM-234 MAT NO 1043



A-107

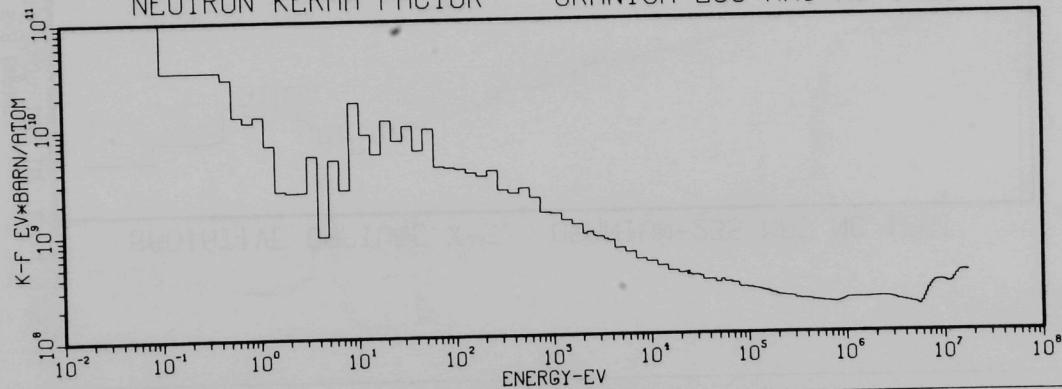
TOTAL X-S.

URANIUM-235 MAT NO 1261

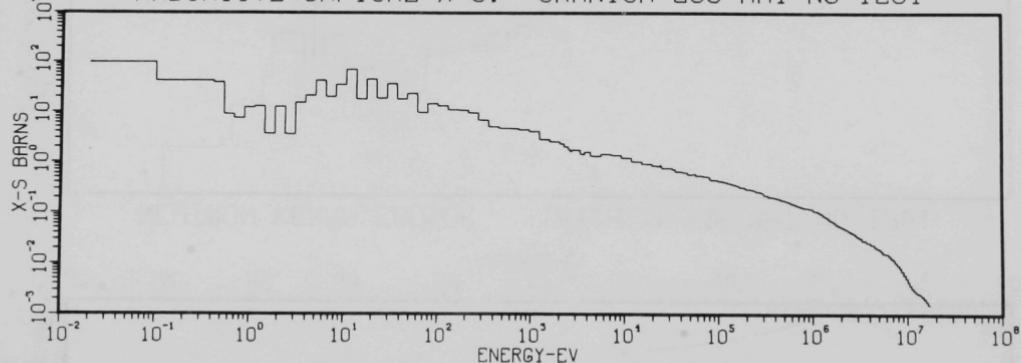


NEUTRON KERMA FACTOR

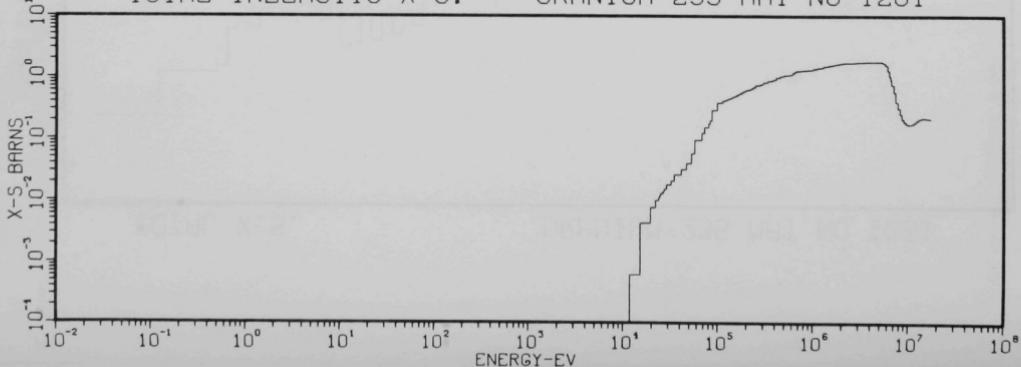
URANIUM-235 MAT NO 1261



RADIATIVE CAPTURE X-S. URANIUM-235 MAT NO 1261



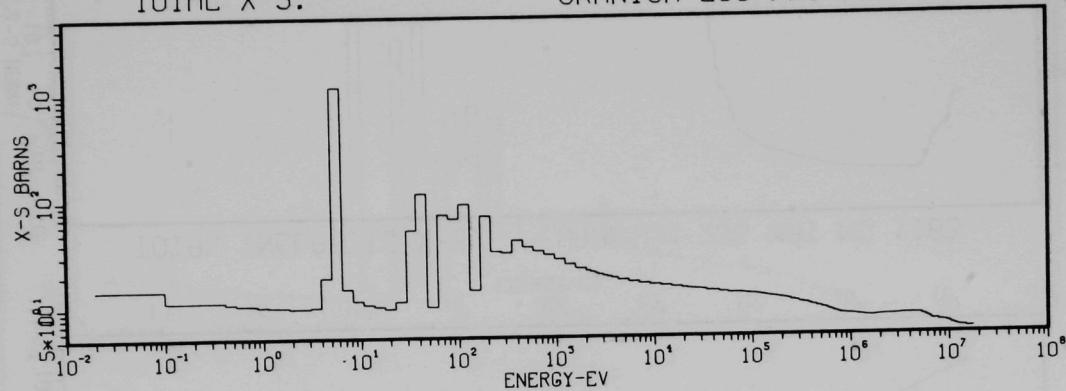
TOTAL INELASTIC X-S. URANIUM-235 MAT NO 1261



601-V

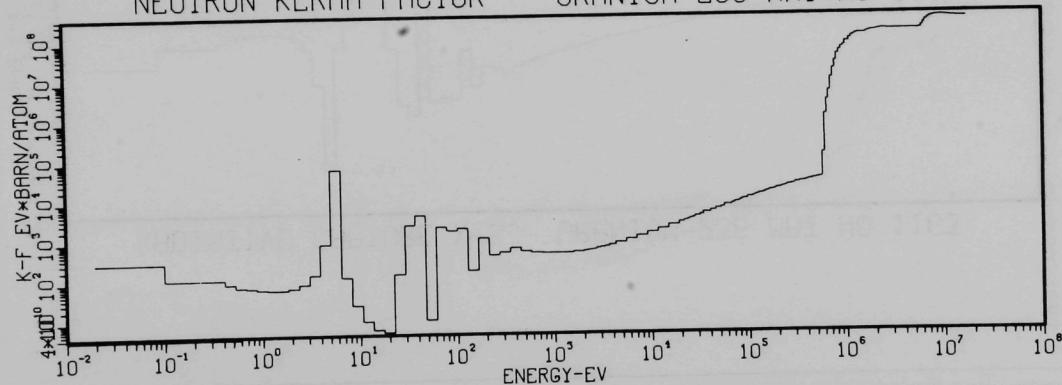
TOTAL X-S.

URANIUM-236 MAT NO 1163

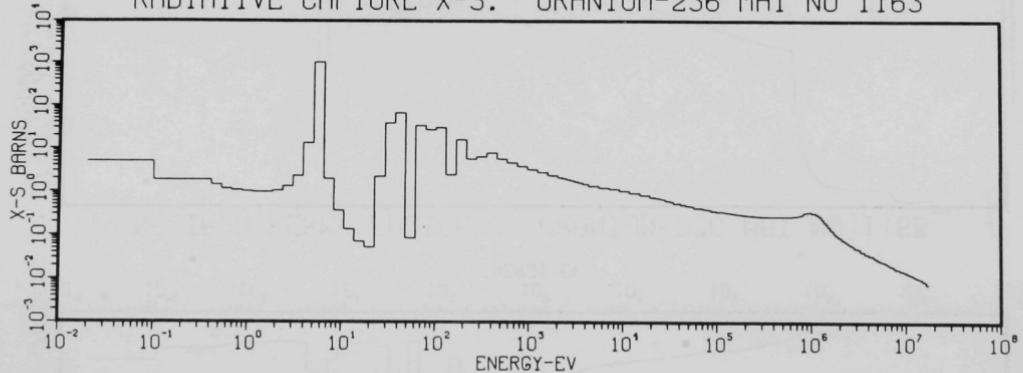


NEUTRON KERMA FACTOR

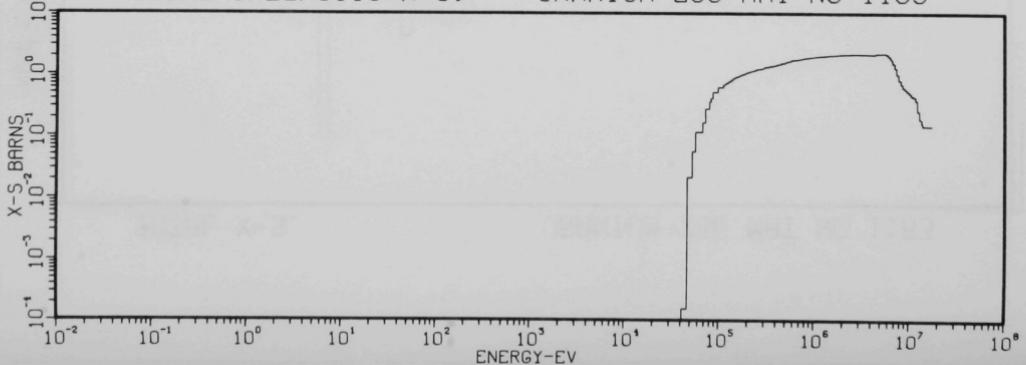
URANIUM-236 MAT NO 1163



RADIATIVE CAPTURE X-S. URANIUM-236 MAT NO 1163

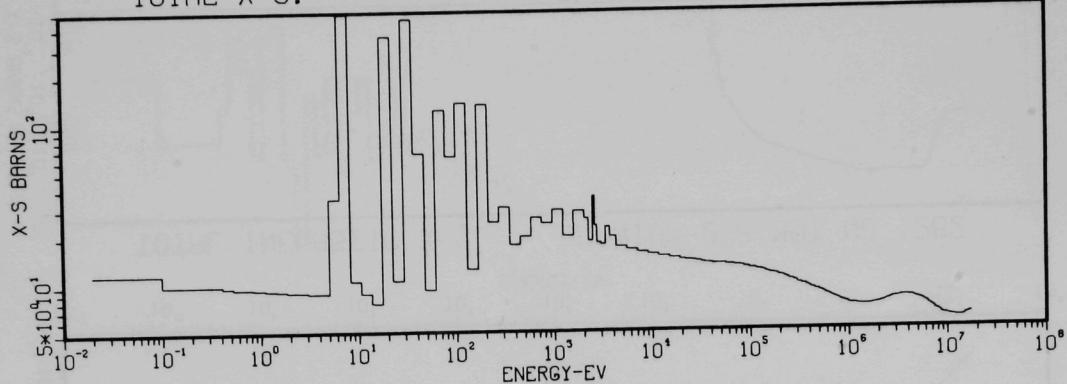


TOTAL INELASTIC X-S. URANIUM-236 MAT NO 1163



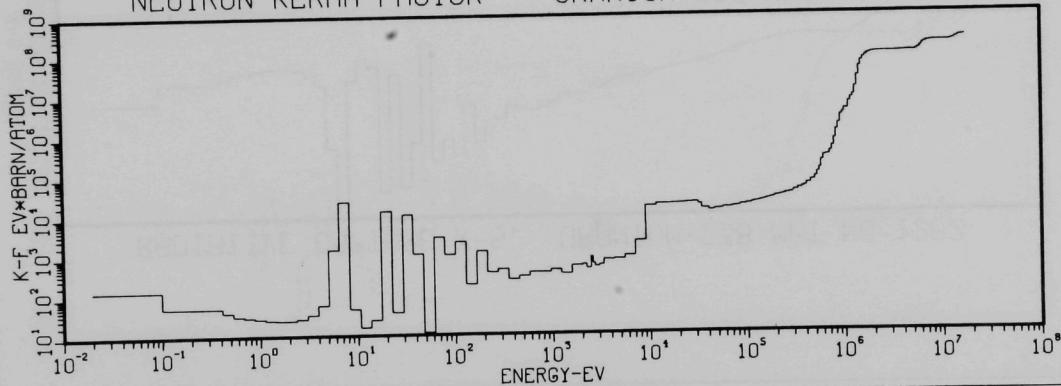
TOTAL X-S.

URANIUM-238 MAT NO 1262



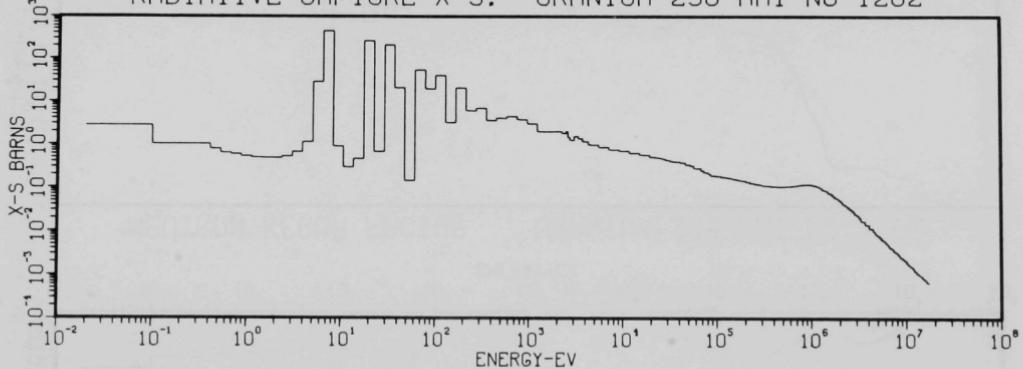
NEUTRON KERMA FACTOR

URANIUM-238 MAT NO 1262

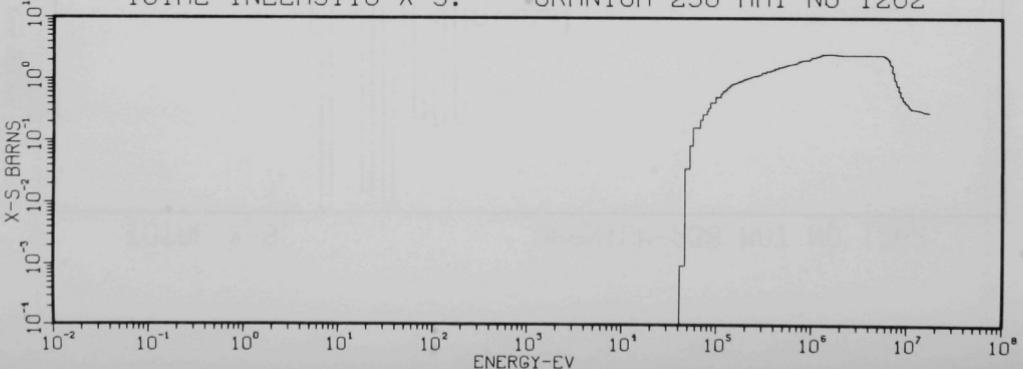


A-111

RADIATIVE CAPTURE X-S. URANIUM-238 MAT NO 1262

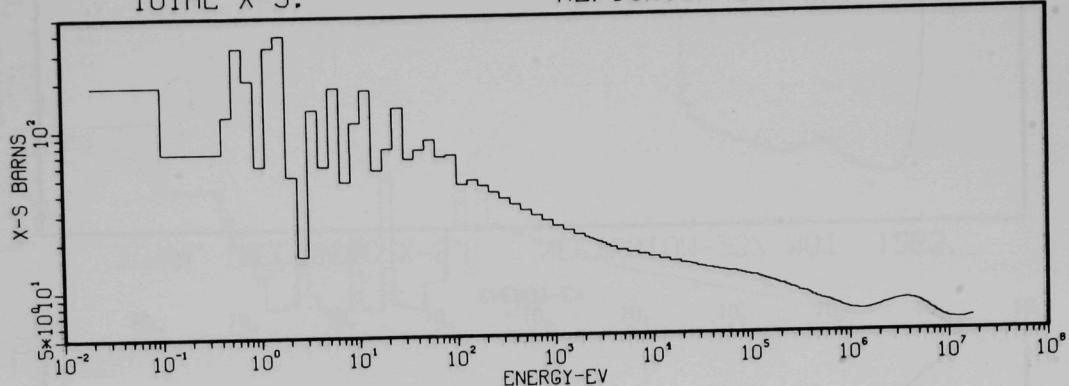


TOTAL INELASTIC X-S. URANIUM-238 MAT NO 1262



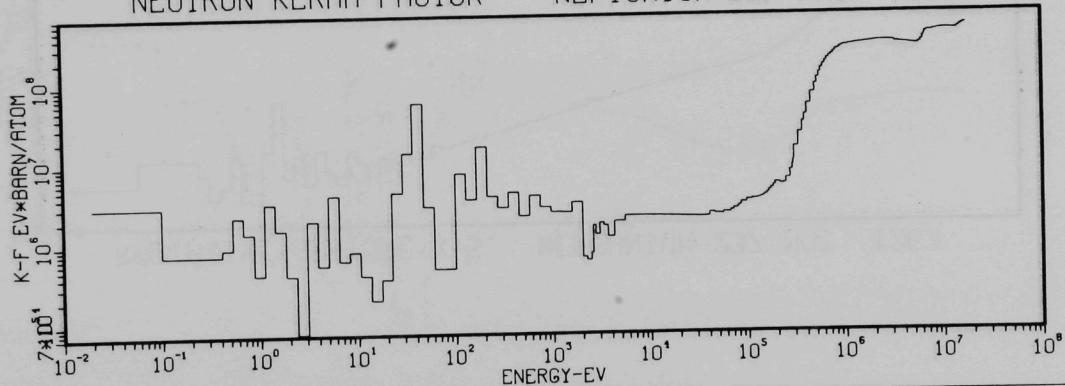
TOTAL X-S.

NEPTUNIUM-237 MAT 1263

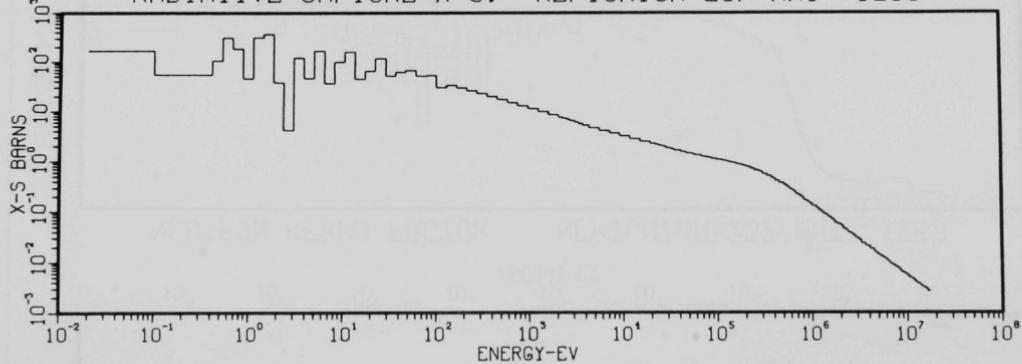


NEUTRON KERMA FACTOR

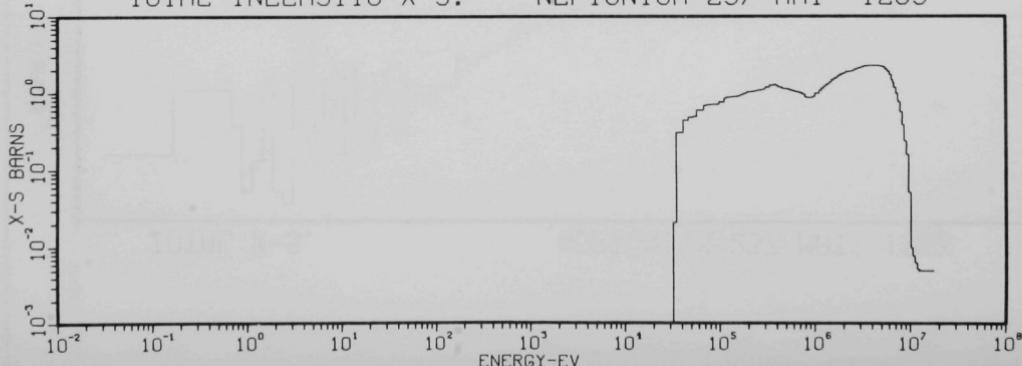
NEPTUNIUM-237 MAT 1263



RADIATIVE CAPTURE X-S. NEPTUNIUM-237 MAT 1263



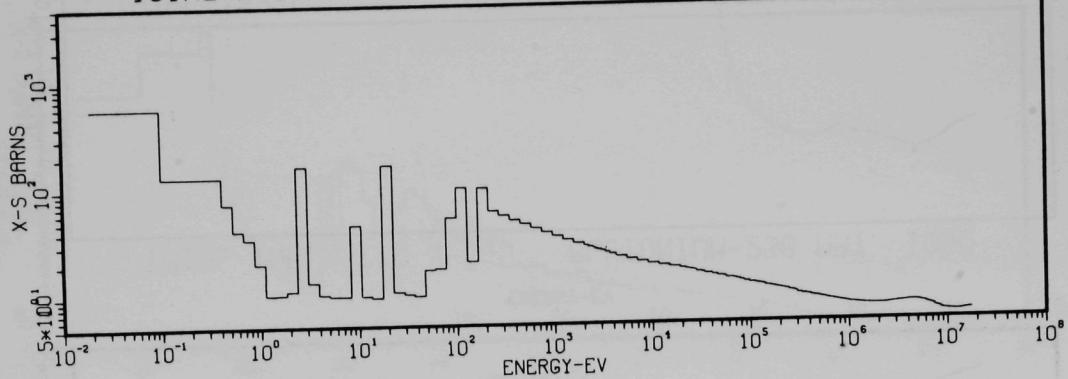
TOTAL INELASTIC X-S. NEPTUNIUM-237 MAT 1263



A-115

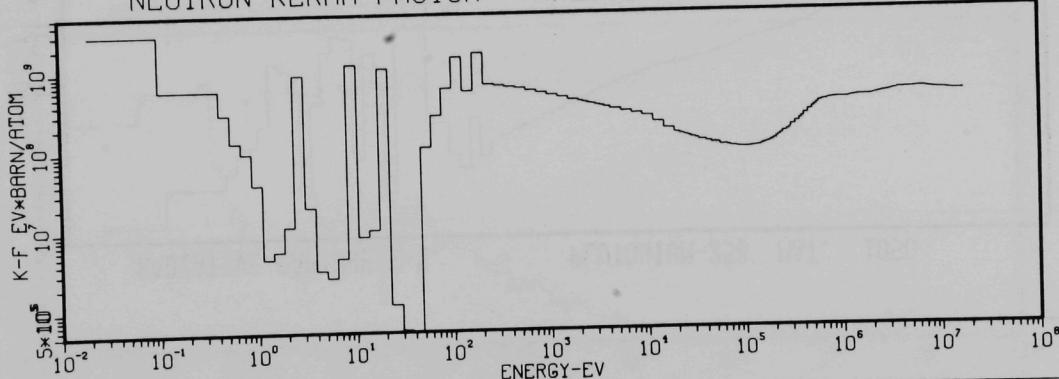
TOTAL X-S.

PLUTONIUM-238 MAT 1050

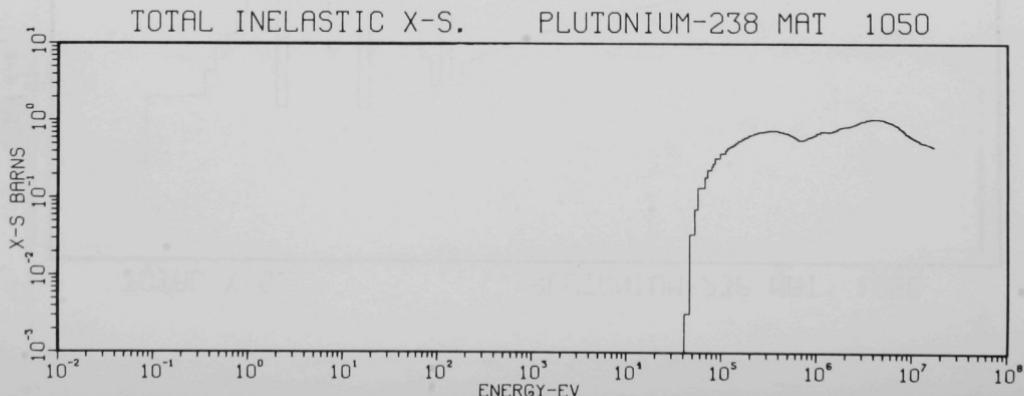
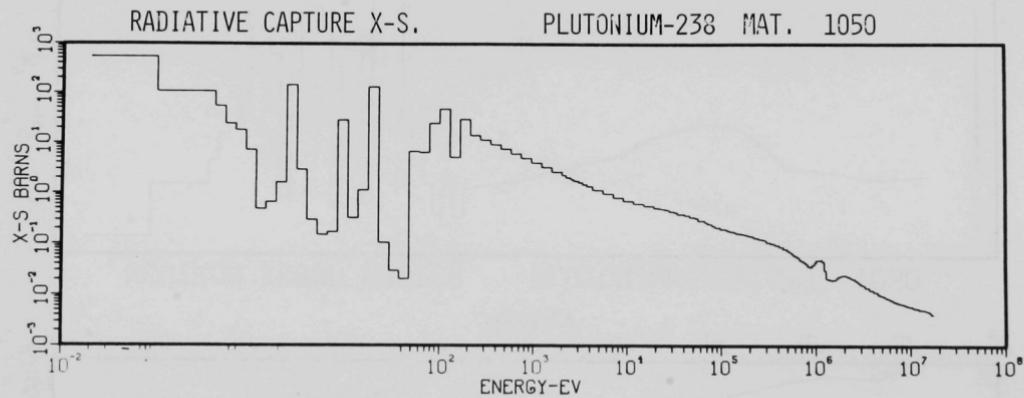


NEUTRON KERMA FACTOR

PLUTONIUM-238 MAT 1050



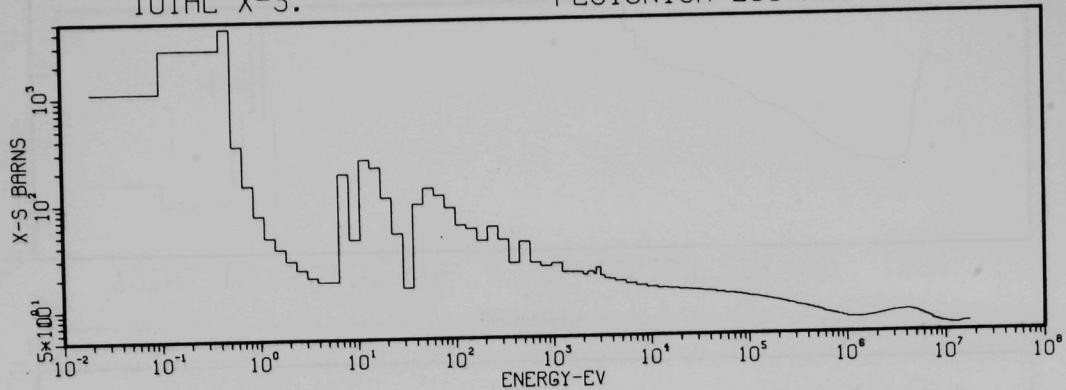
A-111



A-111

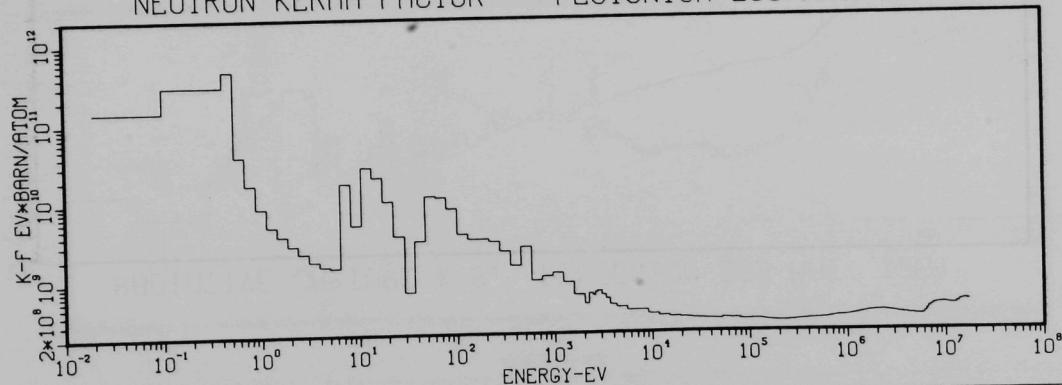
TOTAL X-S.

PLUTONIUM-239 MAT 1264



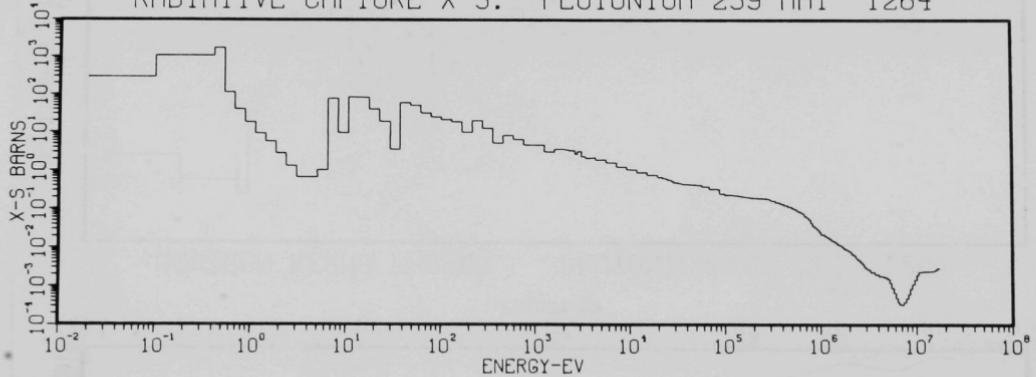
NEUTRON KERMA FACTOR

PLUTONIUM-239 MAT 1264

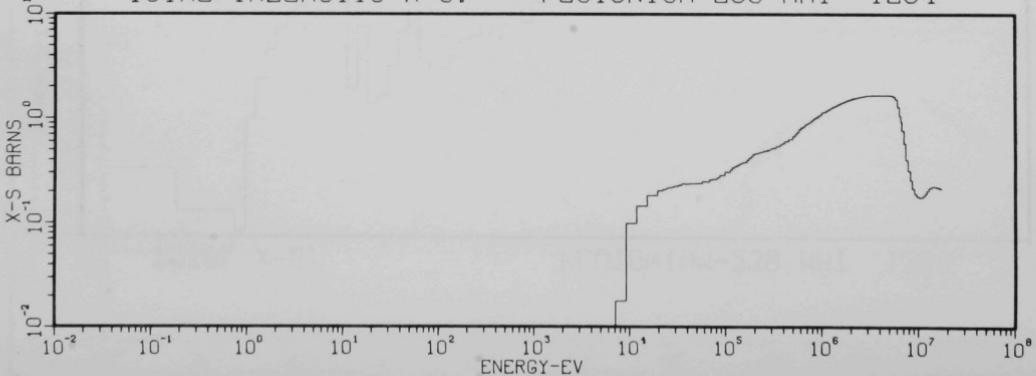


A-113

RADIATIVE CAPTURE X-S. PLUTONIUM-239 MAT 1264



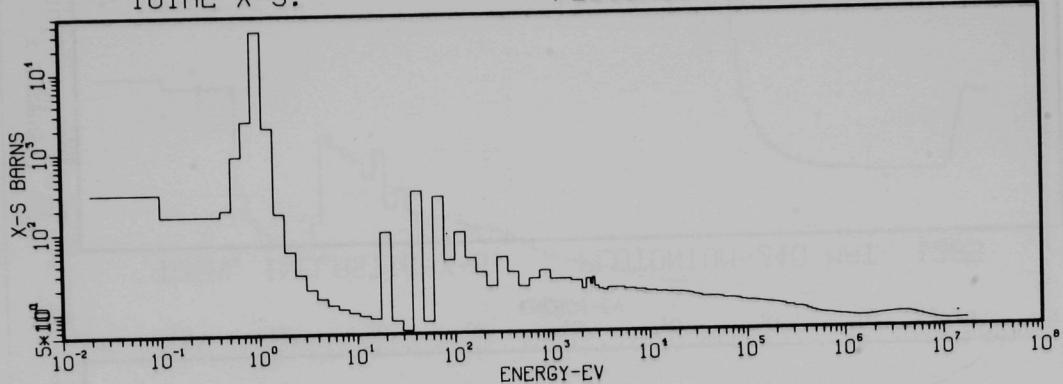
TOTAL INELASTIC X-S. PLUTONIUM-239 MAT 1264



A-119

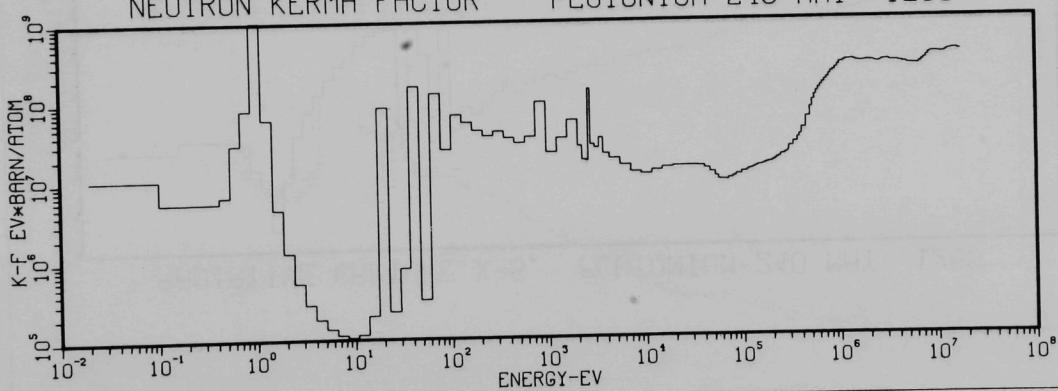
TOTAL X-S.

PLUTONIUM-240 MAT 1265



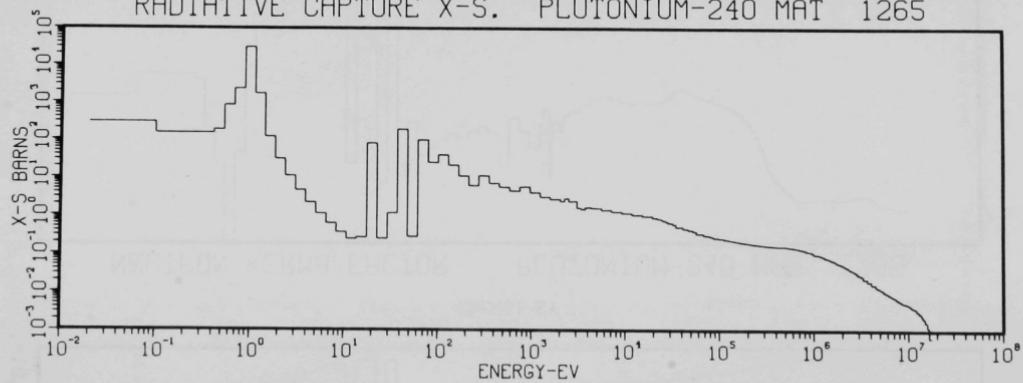
NEUTRON KERMA FACTOR

PLUTONIUM-240 MAT 1265

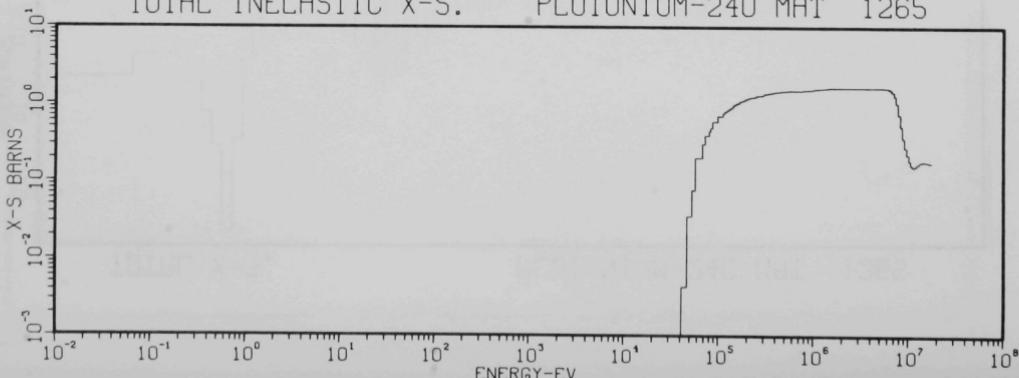


A-120

RADIATIVE CAPTURE X-S. PLUTONIUM-240 MAT 1265

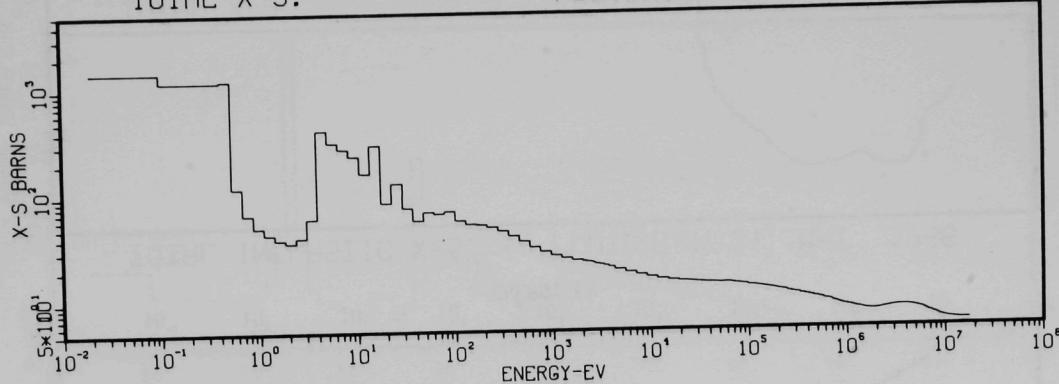


TOTAL INELASTIC X-S. PLUTONIUM-240 MAT 1265



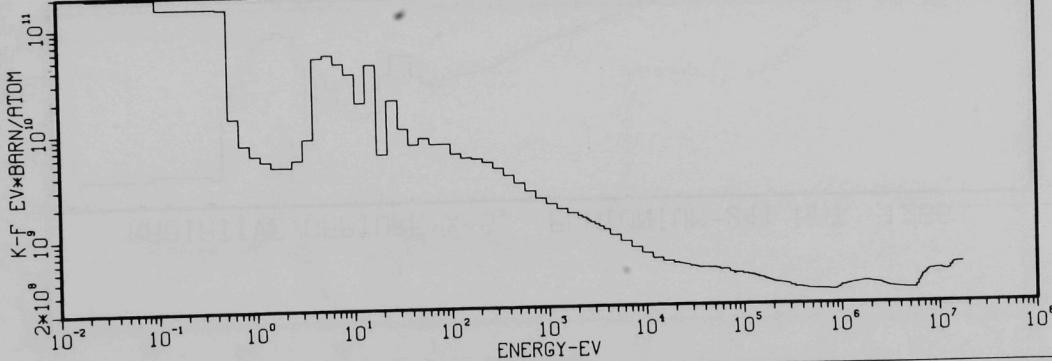
TOTAL X-S.

PLUTONIUM-241 MAT 1266

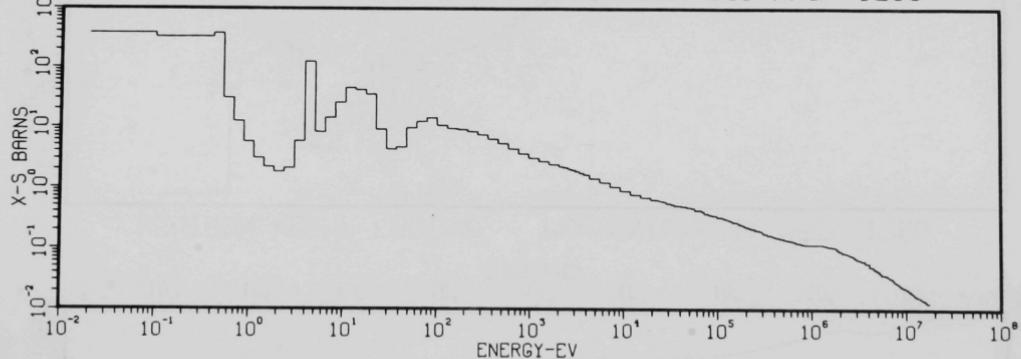


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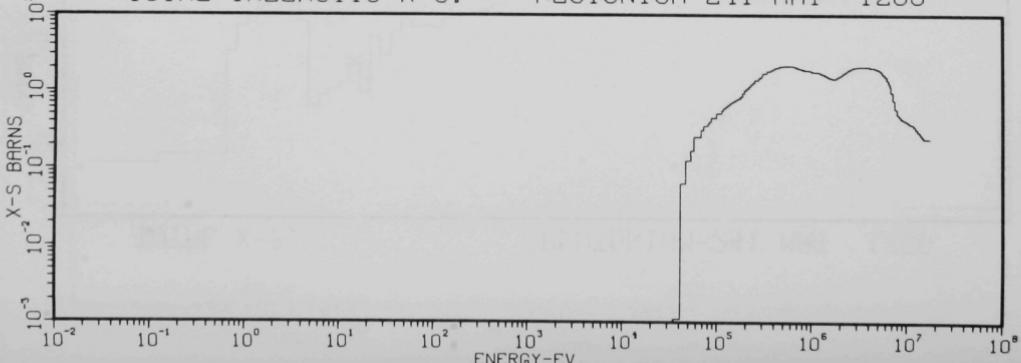
PLUTONIUM-241 MAT 1266



RADIATIVE CAPTURE X-S. PLUTONIUM-241 MAT 1266



TOTAL INELASTIC X-S. PLUTONIUM-241 MAT 1266

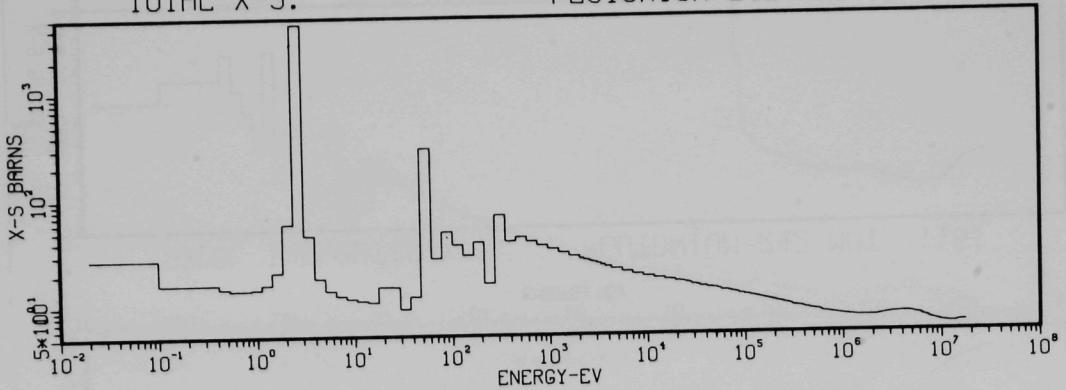


A-122

A-123

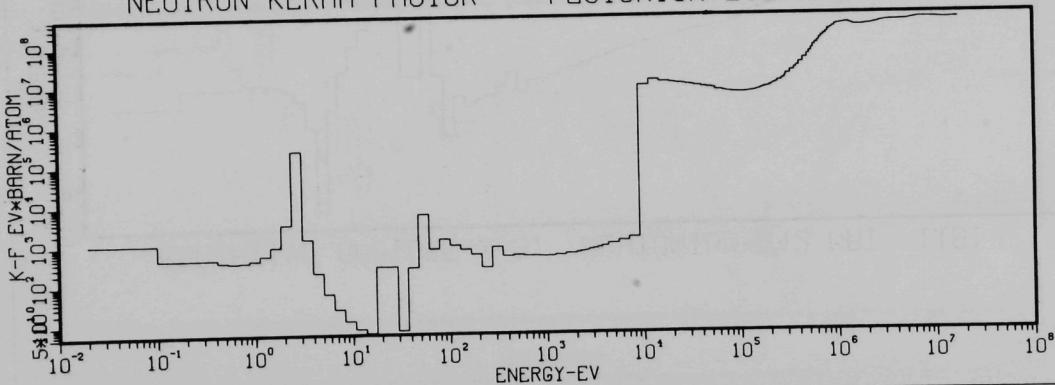
TOTAL X-S.

PLUTONIUM-242 MAT 1161



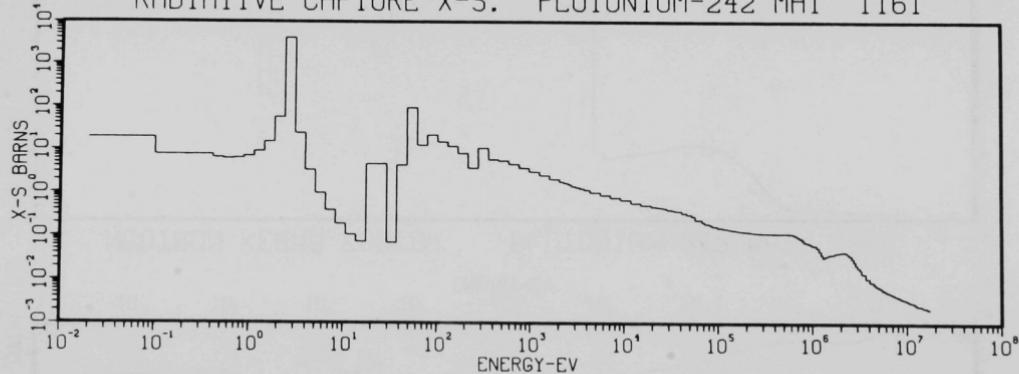
NEUTRON KERMA FACTOR

PLUTONIUM-242 MAT 1161

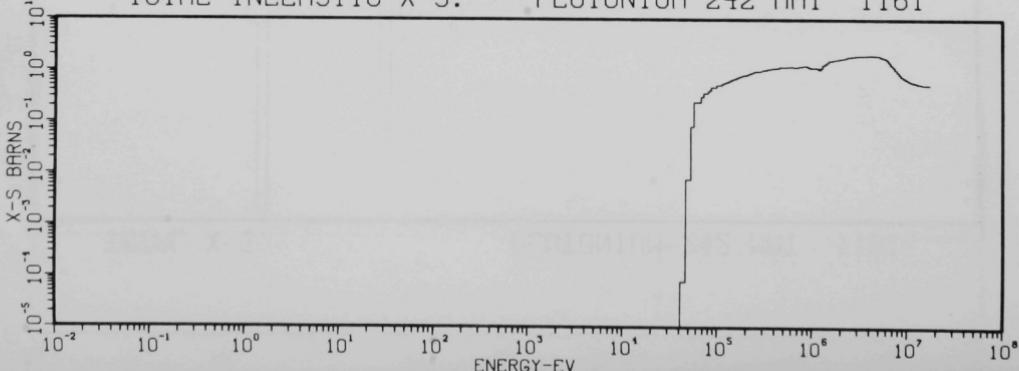


A-124

RADIATIVE CAPTURE X-S. PLUTONIUM-242 MAT 1161



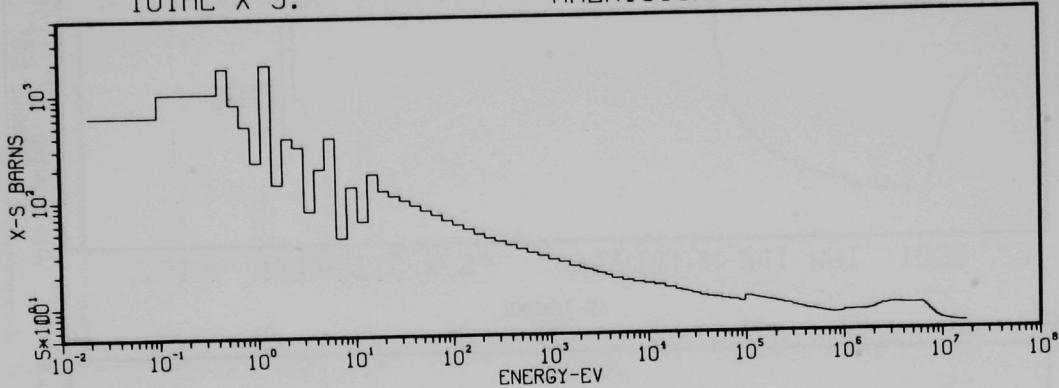
TOTAL INELASTIC X-S. PLUTONIUM-242 MAT 1161



A-125

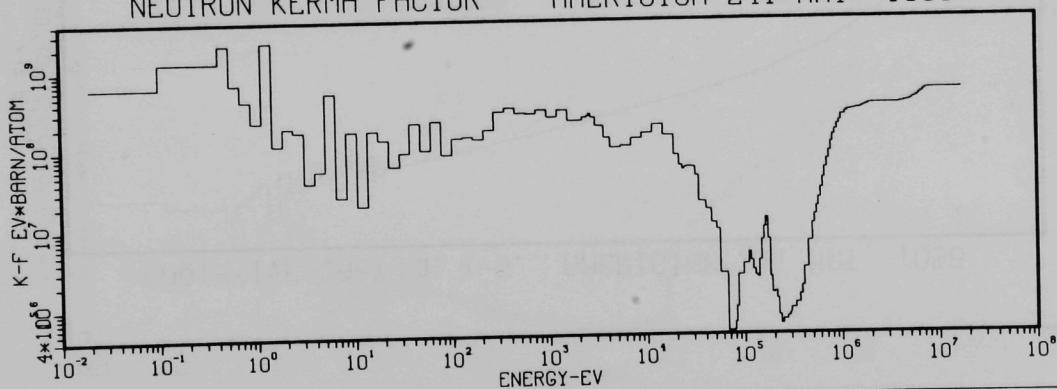
TOTAL X-S.

AMERICIUM-241 MAT 1056

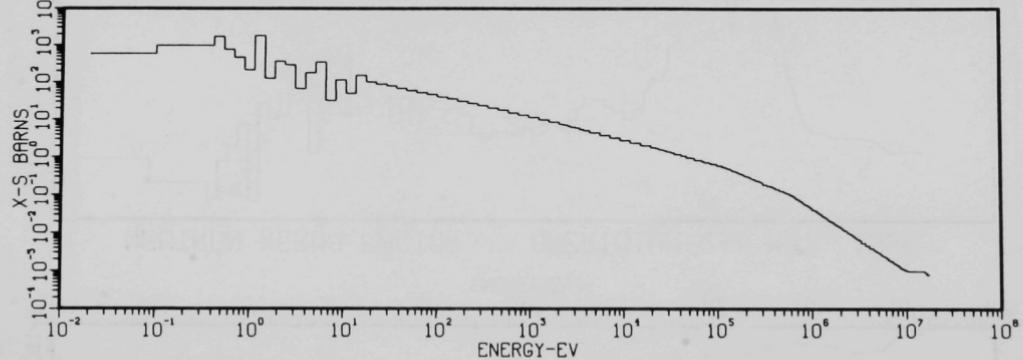


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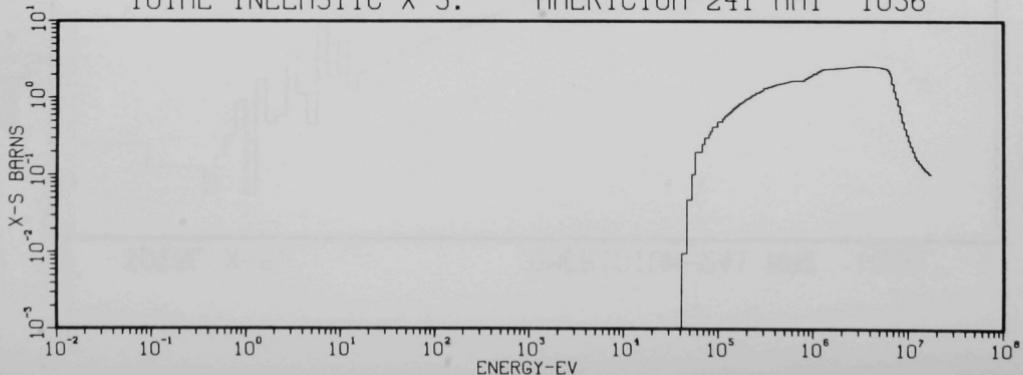
AMERICIUM-241 MAT 1056



RADIATIVE CAPTURE X-S. AMERICIUM-241 MAT 1056



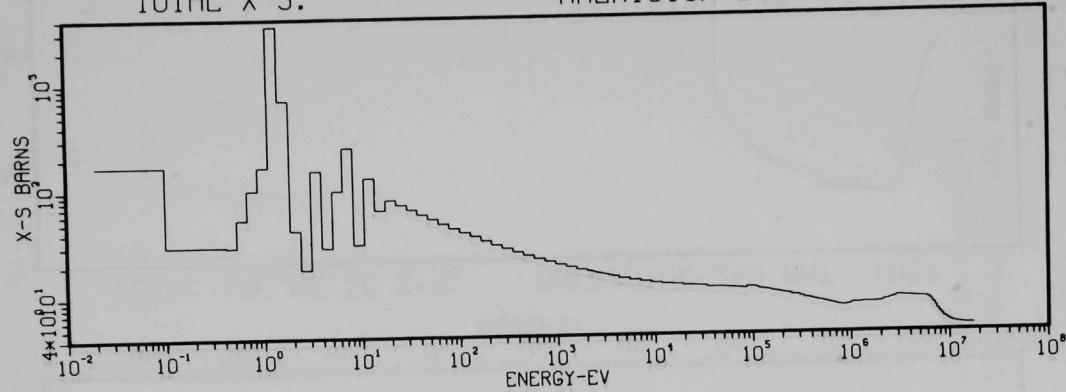
TOTAL INELASTIC X-S. AMERICIUM-241 MAT 1056



A-127

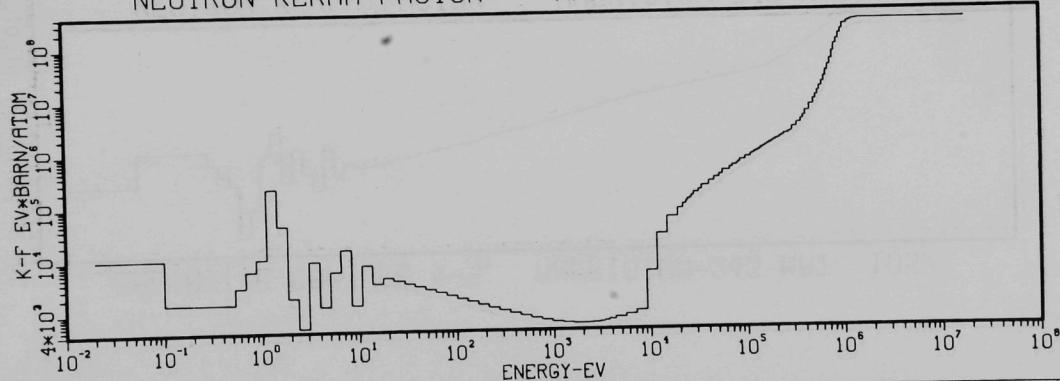
TOTAL X-S.

AMERICIUM-243 MAT 1057

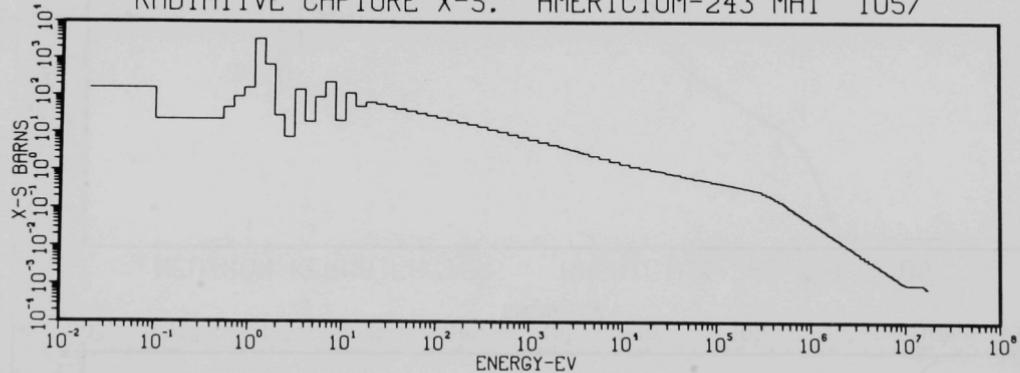


NEUTRON KERMA FACTOR

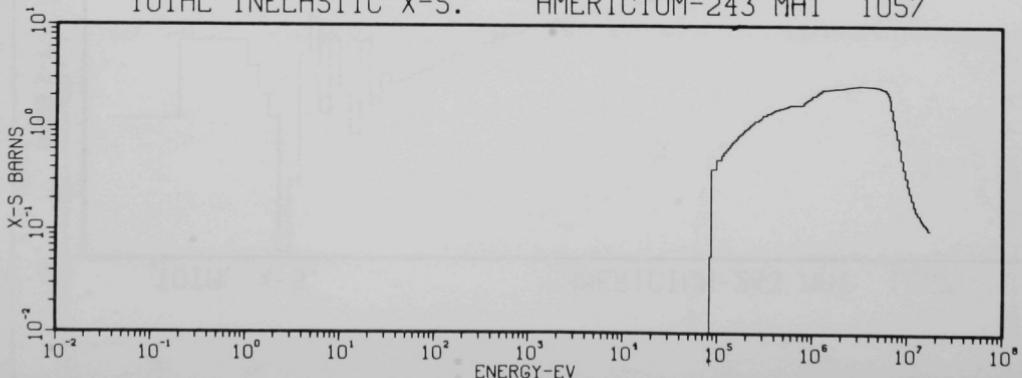
AMERICIUM-243 MAT 1057



RADIATIVE CAPTURE X-S. AMERICIUM-243 MAT 1057



TOTAL INELASTIC X-S. AMERICIUM-243 MAT 1057



APPENDIX B

Decay Type and Average Decay Energy in MeV
Included in MACKLIB Calculations

HYDROGEN H

MAT 1269

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average Decay Energy
1					
2					
102		2.225 + 06			

HELIUM He

MAT 1270

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					

LITHIUM ${}^6\text{Li}$

MAT 1271

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-1.471 + 06			
24		-5.660 + 06			
52		-3.562 + 06			
91	32	-1.471 + 06	-1.471 + 06		
102		7.252 + 06			
103		-2.733 + 06		B ⁻	1.560
107		4.786 + 06			

LITHIUM ${}^7\text{Li}$

MAT 1272

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-4.780 + 05			
16		-7.252 + 06			
24		-8.723 + 06			
51		-4.776 + 05			
91	33	-2.466 + 06	-2.466 + 06		
102		2.033 + 06		B^- , α	2.31
104		-7.760 + 06		B^-	1.56

BERYLLIUM Be

MAT 1289

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
6		-1.680 + 06		α	0.0921
7		-2.430 + 06		α	0.0921
8		-6.760 + 06		α	0.0921
9		-1.128 + 07		α	0.0921
46		-1.680 + 06			
47		-2.430 + 06			
48		-6.760 + 06			
49		-1.128 + 07			
102		6.820 + 06			
103		-1.283 + 07		B^-	6.24
104		-1.466 + 07		B^- , α	9.31
105		-1.044 + 07			
107		-6.000 + 05		B^-	1.56

BORON-10

 ^{10}B

MAT

1273

<u>MT</u>	<u>LR</u>	<u>Q (MR)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-7.170 + 05			
51	31	-7.170 + 05	0.0		
52	31	-1.740 + 06	0.0		
53	31	-2.154 + 06	0.0		
54	31	-3.585 + 06	0.0		
55	22	-4.774 + 06	-4.460 + 06		
56	22	-5.114 + 06	-4.460 + 06		
57	31	-5.166 + 06	0.0		
58	22	-5.183 + 06	-4.460 + 06		
59	22	-5.923 + 06	-4.460 + 06		
60	22	-6.029 + 06	-4.460 + 06		
61	22	-6.133 + 06	-4.460 + 06		
62	35	-6.500 + 06	-5.934 + 06		
63	22	-7.000 + 06	-4.460 + 06		
64	35	-7.500 + 06	-5.934 + 06		
65	28	-8.000 + 06	-6.585 + 06		
66	22	-8.500 + 06	-4.460 + 06		
67	22	-9.000 + 06	-4.460 + 06		
68	35	-9.500 + 06	-5.934 + 06		
69	22	-1.000 + 07	-4.460 + 06		
70	35	-1.050 + 07	-5.934 + 06		
71	35	-1.100 + 07	-5.934 + 06		
72	22	-1.150 + 07	-4.460 + 06		
73	35	-1.200 + 07	-5.934 + 06		
74	35	-1.250 + 07	-5.934 + 06		
75	22	-1.300 + 07	-4.460 + 06		
76	35	-1.350 + 07	-5.934 + 06		
77	35	-1.400 + 07	-5.934 + 06		
78	28	-1.450 + 07	-6.585 + 06		
79	35	-1.500 + 07	-5.934 + 06		
80	35	-1.550 + 07	-5.934 + 06		
81	35	-1.600 + 07	-5.934 + 06		
82	22	-1.650 + 07	-4.460 + 06		
83	35	-1.700 + 07	-5.934 + 06		
84	35	-1.750 + 07	-5.934 + 06		
85	22	-1.800 + 07	-4.460 + 06		
103		2.267 + 05			
104		-4.361 + 06			
107		2.790 + 06			
113		2.318 + 05			
				α	0.0921

BORON ^{11}B

MAT 1160

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-2.140 + 06			
16		-1.145 + 07			
51		-2.140 + 06			
52		-4.458 + 06			
53		-5.030 + 06			
91		-5.873 + 06			
102		3.369 + 06		B^-	6.42
103		-1.073 + 07		B^-	4.86
105		-9.561 + 06			
107		-6.632 + 06		B^-, α	9.31

CARBON C

MAT 1274

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
3		4.947 + 06			
4		-4.433 + 06			
51		-4.433 + 06			
91	23	-7.274 + 06	-7.274 + 06		
102		4.947 + 06			
107		-5.695 + 06			

NITROGEN N

MAT 1275

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-2.313 + 06			
16		-1.055 + 07			
51		-2.313 + 06			
52		-3.945 + 06			
53		-4.913 + 06			
54		-5.106 + 06			
55		-5.691 + 06			
56		-5.834 + 06			
57		-6.198 + 06			
58		-6.444 + 06			
59		-7.028 + 06			
60	28	-7.966 + 06	-7.550 + 06		
61	28	-8.061 + 06	-7.550 + 06		
62		-8.489 + 06			
63	28	-8.750 + 06	-7.550 + 06		
64	28	-9.250 + 06	-7.550 + 06		
65	28	-9.750 + 06	-7.550 + 06		
66	28	-1.025 + 07	-7.550 + 06		
67	28	-1.075 + 07	-7.550 + 06		
68	28	-1.125 + 07	-7.550 + 06		
69	28	-1.175 + 07	-7.550 + 06		
70	28	-1.225 + 07	-7.550 + 06		
71	28	-1.275 + 07	-7.550 + 06		
72	28	-1.325 + 07	-7.550 + 06		
73	28	-1.375 + 07	-7.550 + 06		
74	28	-1.425 + 07	-7.550 + 06		
75	22	-1.475 + 07	-1.161 + 07		
76	28	-1.525 + 07	-7.550 + 06		
77	28	-1.575 + 07	-7.550 + 06		
78	28	-1.625 + 07	-7.550 + 06		
79	28	-1.675 + 07	-7.550 + 06		
80	22	-1.725 + 07	-1.161 + 07		
81	28	-1.775 + 07	-7.550 + 06		
82	28	-1.825 + 07	-7.550 + 06		
102		1.084 + 07			
103		6.264 + 05			
104		-5.325 + 06			
105		-4.015 + 06			
107		-1.573 + 05			
108					

OXYGEN 0

MAT 1276

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4					
51	40	-6.052 + 06		-6.052 + 06	
52		-6.042 + 06			
53		-6.131 + 06			
54		-6.917 + 06			
55		-7.119 + 06			
56	22	-8.872 + 06			
57	22	-9.597 + 06		-7.161 + 06	
58	22	-9.847 + 06		-7.161 + 06	
59		-1.035 + 07		-7.161 + 06	
60		-1.095 + 07			
61	22	-1.108 + 07			
62	22	-1.110 + 07		-7.161 + 06	
63	22	-1.126 + 07		-7.161 + 06	
64	22	-1.144 + 07		-7.161 + 06	
65	22	-1.152 + 07		-7.161 + 06	
66	22	-1.163 + 07		-7.161 + 06	
67	28	-1.205 + 07		-7.161 + 06	
68	22	-1.244 + 07		1.213 + 07	
69	22	-1.253 + 07		-7.161 + 06	
70	22	-1.280 + 07		-7.161 + 06	
71	28	-1.297 + 07		-7.161 + 06	
72	22	-1.315 + 07		-1.213 + 07	
73	22	-1.345 + 07		-7.161 + 06	
74	28	-1.375 + 07		-7.161 + 06	
75	22	-1.405 + 07		-1.213 + 07	
76	22	-1.435 + 07		-7.161 + 06	
77	28	-1.465 + 07		-1.213 + 07	
78	22	-1.495 + 07		-7.161 + 06	
79	22	-1.525 + 07		-7.161 + 06	
80	28	-1.555 + 07		-1.213 + 07	
81	22	-1.585 + 07		-7.161 + 06	
82	28	-1.615 + 07		-1.213 + 07	
83	22	-1.645 + 07		-7.161 + 06	
84	22	-1.675 + 07		-7.161 + 06	
85	28	-1.705 + 07		-1.213 + 07	
86	22	-1.735 + 07		-7.161 + 06	
87	28	-1.765 + 07		-1.213 + 07	
88	22	-1.795 + 07		-7.161 + 06	
89	28	-1.825 + 07		-1.213 + 07	
102	22	-1.855 + 07		-7.161 + 06	
103		4.143 + 06			B-
104		-9.639 + 06			
107		-9.901 + 06			
		-2.214 + 06			

FLUORINE F

MAT 1277

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-1.100 + 05			
16		-1.043 + 07		B ⁺	0.2534
22		-4.878 + 06			
28		-7.993 + 06			
51		-1.100 + 05			
52		-1.970 + 05			
53		-1.417 + 06			
54		-1.458 + 06			
55		-1.554 + 06			
56		-2.780 + 06			
57		-3.907 + 06			
58		-3.998 + 06			
59		-4.032 + 06			
60		-4.378 + 06			
61		-4.555 + 06			
62		-4.557 + 06			
63		-4.648 + 06			
64		-4.683 + 06			
65		-5.106 + 06			
66		-5.340 + 06			
67		-5.428 + 06			
68		-5.464 + 06			
69		-5.499 + 06			
70		-5.540 + 06			
71		-5.630 + 06			
91		-5.943 + 06			
102		6.601 + 06		B ⁻	2.4886
103		-4.036 + 06		B ⁻	1.701
104		-5.768 + 06			
105		-7.557 + 06			
107		-1.523 + 06		B ⁻	2.6924

SODIUM Na

MAT 1156

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-4.390 + 05			
16		-1.241 + 07		B ⁺	0.216
51		-4.390 + 05			
52		-2.078 + 06			
53		-2.393 + 06			
54		-2.640 + 06			
55		-2.705 + 06			
56		-2.983 + 06			
57		-3.680 + 06			
58		-3.880 + 06			
59		-4.430 + 06			
60		-4.770 + 06			
61		-5.380 + 06			
62		-5.530 + 06			
63		-5.760 + 06			
64		-5.955 + 06			
65		-6.079 + 06			
66		-6.270 + 06			
67		-7.110 + 06			
68		-7.790 + 06			
91	4	-8.630 + 06			
102		6.962 + 06		B ⁻	0.557
103		-3.597 + 06		B ⁻	1.909
107		-3.866 + 06		B ⁻	2.4886

MAGNESIUM Mg

MAT 1280

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-5.840 + 05			
16		-7.316 + 06		B ⁺	1.0504
22		-9.313 + 06			
28		-1.170 + 07		B ⁻	0.2195
51		-5.840 + 05			
52		-9.760 + 05			
53		-1.370 + 06			
54		-1.611 + 06			
55		-1.808 + 06			
56		-1.962 + 06			
57		-2.565 + 06			
58		-2.736 + 06			
59		-2.803 + 06			
60		-2.940 + 06			
61		-3.399 + 06			
62		-3.408 + 06			
63		-3.586 + 06			
64		-3.903 + 06			
65		-3.942 + 06			
66		-3.969 + 06			
67		-4.055 + 06			
68		-4.120 + 06			
69		-4.230 + 06			
70		-4.270 + 06			
71		-4.320 + 06			
72		-4.333 + 06			
73		-4.351 + 06			
74		-4.351 + 06			
75		-4.704 + 06			
76		-4.712 + 06			
77		-4.835 + 06			
78		-5.230 + 06			
79		-6.000 + 06			
80		-6.440 + 06			
81		-7.350 + 06			
82		-7.560 + 06			
83		-7.620 + 06			
84		-7.750 + 06			
85		-8.120 + 06			
86		-8.350 + 06			
87		-8.440 + 06			
88		-8.441 + 06			
89		-8.650 + 06			
90		-8.880 + 06			
91		-4.300 + 06			
102		8.167 + 06		B ⁻	0.0763
103		-3.040 + 06		B ⁻	0.9486
107		4.600 + 05		B ⁻	0.2102

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-8.430 + 05			
16		-1.306 + 07			
51	31	-8.430 + 05			
52	31	-1.013 + 06			
53	31	-2.210 + 06			
54	31	-2.732 + 06			
55	31	-2.980 + 06			
56	31	-3.001 + 06			
57	31	-3.678 + 06			
58	31	-3.956 + 06			
59	31	-4.055 + 06			
60	31	-4.409 + 06			
61	31	-4.508 + 06			
62	31	-4.580 + 06			
63	31	-4.811 + 06			
64	31	-5.250 + 06			
65	31	-5.750 + 06			
66	31	-6.250 + 06			
66	31	-6.250 + 06			
67	31	-6.750 + 06			
68	31	-7.250 + 06			
69	31	-7.750 + 06			
70	31	-8.250 + 06			
71	31	-8.750 + 06			
72	31	-9.250 + 06			
73	31	-9.750 + 06			
74	31	-1.025 + 07			
75	28	-1.075 + 07	-8.271 + 06		
76	31	-1.125 + 07			
77	31	-1.175 + 07			
78	28	-1.225 + 07	-8.271 + 06		
79	31	-1.275 + 07			
80	28	-1.325 + 07	-8.271 + 06		
81	28	-1.375 + 07	-8.271 + 06		
82	22	-1.425 + 07	-1.010 + 07		
83	28	-1.475 + 07	-8.271 + 06		
84	28	-1.525 + 07	-8.271 + 06		
85	28	-1.575 + 07	-8.271 + 06		
86	22	-1.625 + 07	-1.010 + 07		
87	28	-1.675 + 07	-8.271 + 06		
88	28	1.737 + 07	-8.271 + 06		
89	22	-1.813 + 07	-1.010 + 07		
90	28	-1.887 + 07	-8.271 + 06		
102		7.724 + 07		B ⁻	1.2448
103		-1.828 + 06		B ⁻	0.7055
104		-6.046 + 06			
105		-1.088 + 07		B ⁻	0.5570
107		-3.132 + 06			

SILICON Si

MAT 1194

<u>MT</u>	<u>LR</u>	<u>Q (LR)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-1.273 + 06			
16		-8.474 + 06		B ⁺	1.612
22		-9.985 + 06		B ⁻	0.02145
28		-1.159 + 07		B ⁻	0.02847
51		-1.273 + 06			
52		-1.779 + 06			
53		-2.028 + 06			
54		-2.235 + 06			
55		-2.425 + 06			
56		-3.068 + 06			
57		-3.498 + 06			
58		-3.624 + 06			
59		-3.770 + 06			
60		-3.788 + 06			
61		-4.617 + 06			
62		-4.809 + 06			
63		-4.830 + 06			
64		-4.975 + 06			
65		-6.272 + 06			
66		-6.690 + 06			
67		-6.878 + 06			
68		-6.887 + 06			
69		-7.380 + 06			
70		-7.415 + 06			
71		-7.798 + 06			
72		-7.935 + 06			
91		-4.000 + 06			
102		8.768 + 06		B ⁻	0.0208
103		-3.860 + 06		B ⁻	0.3881
104		-9.358 + 06		B ⁻	0.08698
107		-2.650 + 06		B ⁻	0.02187

CHLORINE C1

MAT 1149

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4			-1.220 + 06		
16			-1.208 + 07	B ⁺	1.094
22			-6.990 + 06	B ⁺	0.4992
28			-6.370 + 06		
51			-1.220 + 06		
52			-1.762 + 08		
53			-2.645 + 06		
54			-2.695 + 06		
55			-3.006 + 06		
56			-3.163 + 06		
57			-4.058 + 06		
58			-4.113 + 06		
59			-4.174 + 06		
60			-5.130 + 06		
61			-5.220 + 06		
62			-6.040 + 06		
63			-6.100 + 06		
91					
102			7.976 + 06	B ⁻	0.3528
103			6.151 + 05	B ⁻	0.2128
107			8.925 + 0.05	B ⁻	1.0177

POTASSIUM K

MAT 1150

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-1.003 + 06			
16		-1.307 + 07		B ⁺	3.2724
22		-7.365 + 06			
28		-6.424 + 06			
51		-2.526 + 06			
52		-2.817 + 06			
53		-3.021 + 06			
54		-3.603 + 06			
55		-3.879 + 06			
56		-3.935 + 06			
57		-4.122 + 06			
58		-4.678 + 06			
59		-5.280 + 06			
60		-5.370 + 06			
61		-5.620 + 06			
62		-5.740 + 06			
63		-5.960 + 06			
64		-6.120 + 06			
65		-6.210 + 06			
66		-6.350 + 06			
67		-6.500 + 06			
91		-1.003 + 06			
102		7.800 + 06		B ⁻	0.104
103		2.170 + 05		B ⁻	0.0269
107		1.363 + 06		B ⁻	0.0966

CALCIUM Ca

MAT 1195

MT	LR	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
3					
4		-1.158 + 06			
16		-1.114 + 07		B ⁺	2.471
22		-7.040 + 06			
28		-8.330 + 06		B ⁻	0.010767
51		-1.158 + 06			
52		-3.354 + 06			
53		-3.737 + 06			
54		-3.904 + 06			
55		-4.492 + 06			
56		-5.212 + 06			
57		-5.249 + 06			
58		-5.279 + 06			
59		-5.615 + 06			
60		-5.627 + 06			
61		-5.900 + 06			
62		-6.025 + 06			
63		-6.029 + 06			
64		-6.285 + 06			
65		-6.510 + 06			
66		-6.752 + 06			
67		-7.114 + 06			
68		-7.280 + 06			
69		-7.536 + 06			
70		-7.760 + 06			
71		-8.020 + 06			
72		-8.271 + 06			
73		-8.540 + 06			
91		-8.670 + 06			
102		8.363 + 06		B ⁻	0.00318
103		-5.250 + 05		B ⁻	0.0603
104		-6.019 + 06			
105		-1.293 + 07			
106		-6.991 + 06		B ⁻	0.008337
107		1.749 + 06		B ⁻	0.00963
108		-5.037 + 06		B ⁻	0.0026
111		-8.112 + 06		B ⁻	0.0811
112		-6.966 + 06		B ⁻	

TITANIUM Ti

MAT 1286

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-2.440 + 05			
16		-1.163 + 07		B ⁺	0.0353
51		-9.870 + 05			
91		-2.440 + 05			
102		8.140 + 06		B ⁻	0.0474
103		-3.210 + 06		B ⁻	0.3196
107		-2.030 + 06		B ⁻	0.07461

VANADIUM V

MAT 1196

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-3.190 + 05			
16		-1.106 + 07			
22		-1.030 + 07			
28		-8.057 + 06			
51		-3.190 + 05			
52		-9.290 + 05			
53		-1.608 + 06			
54		-1.812 + 06			
91		-2.409 + 06			
102		7.304 + 06		B ⁻	1.07
103		-1.679 + 06		B ⁻	0.934
104		-5.833 + 06			
105		-1.052 + 07			
107		-2.047 + 06		B ⁻	0.210

CHROMIUM Cr

MAT 1191

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-5.640 + 05			
16		-7.940 + 06		B ⁺	0.02621
22		-7.927 + 06			
28		-9.588 + 06		B ⁻	0.1275
51		-5.640 + 05			
52		-7.831 + 05			
53		-8.348 + 05			
54		-1.006 + 06			
55		-1.287 + 06			
56		-1.434 + 06			
57		-1.539 + 06			
58		-1.973 + 06			
59		-2.173 + 06			
60		-2.233 + 06			
61		-2.321 + 06			
62		-2.370 + 06			
63		-2.647 + 06			
64		-2.661 + 06			
65		-2.768 + 06			
66		-2.827 + 06			
67		-2.965 + 06			
68		-3.084 + 06			
69		-3.114 + 06			
70		-3.162 + 06			
71		-3.352 + 06			
72		-3.414 + 06			
73		-3.593 + 06			
74		-3.617 + 06			
75		-3.713 + 06			
76		-3.771 + 06			
77		-3.982 + 06			
78		-4.039 + 06			
79		-4.563 + 06			
80		-4.630 + 06			
81		-4.837 + 06			
82		-5.097 + 06			
83		-5.292 + 06			
84		-5.585 + 06			
85		-5.737 + 06			

CHROMIUM Cr (Contd.)

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
86		-6.070 + 06			
87		-6.154 + 06			
88		-6.490 + 06			
89		-6.820 + 06			
90		-7.070 + 06			
91		-1.825 + 06			
102		9.237 + 06		B ⁻	0.02528
103		-2.569 + 05		B ⁻	1.02899
104		-7.364 + 06		B ⁻	0.12754
105		-9.965 + 06		B ⁻ ,B ⁺	0.03351
106		-8.628 + 06		B ⁻	0.02223
107		1.794 + 06			

MANGANESE Mn

MAT 1197

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-1.258 + 05			
16		-1.023 + 07			
17		-1.917 + 07			
22		-7.931 + 06			
28		-8.063 + 06			
51		-1.258 + 05			
52		-9.840 + 04			
53		-1.292 + 06			
54		-1.528 + 06			
55		-1.883 + 06			
91		-1.883 + 06			
102		7.270 + 06		B-	0.777
103		-1.810 + 06		B-	1.06228
104		-5.839 + 06			
106		-1.238 + 07			
107		-6.216 + 05			

IRON Fe

MAT 1192

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-8.460 + 05			
16		-1.120 + 07		B ⁺	0.06421
22		-7.619 + 06			
28		-1.019 + 07		B ⁻	0.01968
51		-8.460 + 05			
52		-1.408 + 06			
53		-2.084 + 06			
54		-2.654 + 06			
55		-2.939 + 06			
56		-2.957 + 06			
57		-3.119 + 06			
58		-3.122 + 06			
59		-3.368 + 06			
60		-3.388 + 06			
61		-3.445 + 06			
62		-3.450 + 06			
63		-3.600 + 06			
64		-3.605 + 06			
65		-3.747 + 06			
66		-3.829 + 06			
67		-3.856 + 06			
68		-4.046 + 06			
69		-4.099 + 06			
70		-4.116 + 06			
71		-4.298 + 06			
72		-4.300 + 06			
73		-4.389 + 06			
74		-4.395 + 06			
75		-4.453 + 06			
76		-4.505 + 06			
91		-4.531 + 06			
102		7.803 + 06		B ⁻	0.000485
103		8.900 + 04		B ⁻	0.738
104		-7.965 + 06		B ⁻	0.019778
105		-1.193 + 07		B ⁺	0.0087
106		-1.054 + 07		B ⁻	0.02489
107		8.484 + 05		B ⁻	0.9768

COBALT Co

MAT 1199

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-1.099 + 06			
16		-1.046 + 07		B ⁺	0.0736
51		-1.099 + 06			
52		-1.190 + 06			
53		-1.291 + 06			
54		-1.460 + 06			
55		-1.744 + 06			
56		-2.070 + 06			
57		-2.160 + 06			
58		-2.350 + 06			
59		-2.500 + 06			
91					
102		7.490 + 06			
103		-7.830 + 05		B ⁻	0.1564
104		-5.145 + 00			
105		-8.930 + 06			
107		3.178 + 05		B ⁻	0.777

NICKEL Ni

MAT 1190

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-1.172 + 06			
16		-7.820 + 06		B ⁺	0.2601
28		-8.177 + 06		B ⁻	0.0328
51		-1.172 + 06			
52		-1.332 + 06			
53		-1.454 + 06			
54		-2.158 + 06			
55		-2.286 + 06			
56		-2.459 + 06			
57		-2.506 + 06			
58		-2.625 + 06			
59		-2.775 + 06			
60		-2.902 + 06			
61		-2.942 + 06			
62		-3.038 + 06			
63		-3.123 + 06			
64		-3.264 + 06			
65		-3.420 + 06			
91		-3.441 + 06			
102		8.600 + 06		B ⁻	0.007377
103		3.947 + 05		B ⁻	0.0838
107		2.890 + 06		B ⁻	0.01967

COPPER Cu

MAT 1295

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-6.700 + 05			
16		-9.900 + 06		B ⁺	0.9441
17					
22		-5.777 + 06			
28		-6.120 + 06			
51		-6.700 + 05			
52		-7.700 + 05			
53		-9.620 + 05			
54		-1.115 + 06			
55		-1.326 + 06			
56		-1.412 + 06			
57		-1.482 + 06			
58		-1.547 + 06			
59		-1.623 + 06			
60		-1.725 + 06			
61		-1.865 + 06			
91		-1.900 + 06			
102		7.750 + 06		B ⁻ ,B ⁺	0.4694
103		7.086 + 05		B ⁻	0.196524
104		-3.897 + 06			
106		-9.517 + 06			
107		1.693 + 06		B ⁻	0.311781

NIOBIUM Nb

MAT 1189

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
4		-2.900 + 04			
16		-8.826 + 06			
17		-1.672 + 07			
22		-1.946 + 06			
51		-2.900 + 04			
52		-7.400 + 05			
53		-8.100 + 05			
54		-9.590 + 05			
55		-1.070 + 06			
56		-1.315 + 06			
57		-1.488 + 06			
58		-1.674 + 06			
59		-1.947 + 06			
60		-2.159 + 06			
61		-2.335 + 06			
62		-2.519 + 06			
91		-2.550 + 06			
102		7.214 + 06			
103		7.190 + 05			
107		4.914 + 06		B ⁻	0.931

MOLYBDENUM Mo

MAT 1287

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
4		-2.470 + 05			
16		-7.800 + 06		B ⁺	0.284
17		-1.480 + 07		B ⁺	0.07129
91					
102		7.250 + 06		B ⁻	0.1967

TANTALUM Ta

MAT 1285

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
4		-6.200 + 03			
16		-7.630 + 06			
17		-1.422 + 07			
51		-6.200 + 03			
52		-1.361 + 05			
53		-1.586 + 05			
54		-3.015 + 05			
55		-3.375 + 05			
56		-4.822 + 05			
57		-4.950 + 05			
58		-6.200 + 05			
59		-7.200 + 05			
60		-9.250 + 05			
91					
102		6.070 + 06		B-	0.1233
103		-2.390 + 05			

TUNGSTEN-182

 ^{182}W

MAT

1128

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-1.010 + 05			
16		-8.050 + 06			
17		-1.470 + 07			
28		-7.080 + 06			
51		-1.010 + 05			
52		-3.290 + 05			
53		-6.800 + 05			
54		-1.220 + 06			
55		-1.258 + 06			
56		-1.289 + 06			
57		-1.331 + 06			
58		-1.374 + 06			
91		-9.940 + 05			
102		6.191 + 06			
103		-1.022 + 06			
107		7.750 + 06			

TUNGSTEN-183

 ^{183}W

MAT

11129

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
4		-4.650 + 04			
16		-6.190 + 06			
17		-1.420 + 07			
28		-7.210 + 06			
51		-4.650 + 04			
52		-9.900 + 04			
53		-2.070 + 05			
54		-2.090 + 05			
55		-2.920 + 05			
56		-3.090 + 05			
57		-4.120 + 05			
58		-4.530 + 05			
59		-5.950 + 05			
91		-5.970 + 05			
102		7.412 + 06			
103		-2.860 + 05		B ⁻	0.2085
107		8.140 + 06			

TUNGSTEN-184

 ^{184}W

MAT 1130

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-1.120 + 05			
16		-7.410 + 06			
17		-1.360 + 07			
28		-7.700 + 06		B ⁻	0.2085
51		-1.120 + 05			
52		-3.650 + 05			
53		-7.480 + 05			
54		-9.040 + 05			
55		-1.007 + 06			
56		-1.135 + 06			
57		-1.223 + 06			
58		-1.270 + 06			
59		-1.287 + 06			
91		-9.950 + 05			
102		5.750 + 06		B ⁻	0.1309
103		-2.250 + 06		B ⁻	0.428
107		8.370 + 06		B ⁻	0.12329

TUNGSTEN-186

 ^{186}W

MAT

1131

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-1.220 + 05			
16		-7.200 + 06			
17		-1.295 + 07			
28		-8.380 + 06		B ⁻	0.5023
51		-1.220 + 05			
52		-4.010 + 05			
53		-7.300 + 05			
54		-8.400 + 05			
55		-8.500 + 05			
56		-9.600 + 05			
57		-1.040 + 06			
58		-1.110 + 06			
59		-1.250 + 06			
91		-9.950 + 05			
102		5.467 + 06		B ⁻	0.34138
103		-3.120 + 06		B ⁻	0.885
107		8.410 + 06		B ⁻	0.8135

STEREOR.D

LEAD Pb

MAT 1288

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average Decay Energy
1					
2					
3					
4		-5.700 + 05			
16		-6.733 + 06			
17		-1.411 + 07			
51		-5.700 + 05			
52		-8.030 + 05			
53		-8.980 + 05			
54		-1.175 + 06			
55		-1.341 + 06			
56		-1.462 + 06			
57		-1.633 + 06			
58		-1.682 + 06			
59		-1.762 + 06			
60		-1.998 + 06			
61		-2.160 + 06			
62		-2.340 + 06			
63		-2.385 + 06			
64		-2.615 + 06			
65		-2.624 + 06			
66		-2.634 + 06			
67		-2.783 + 06			
68		-3.017 + 06			
69		-3.057 + 06			
70		-3.198 + 06			
71		-3.250 + 06			
72		-3.382 + 06			
73		-3.453 + 06			
74		-3.475 + 06			
75		-3.560 + 06			
76		-3.708 + 06			
77		-3.750 + 06			
78		-3.854 + 06			
79		-3.920 + 06			
80		-3.989 + 06			
81		-4.078 + 06			
82		-4.125 + 06			
83		-4.200 + 06			
84		-4.288 + 06			
85		-4.339 + 06			
91		-4.400 + 06			
102		5.415 + 06		B-	0.107312

THORIUM Th

MAT 1296

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
4		-5.000 + 04			
16		-6.340 + 06		B ⁻	0.06715
17		-1.137 + 07			
18					
51		-5.000 + 04			
52		-1.700 + 05			
53		-3.300 + 05			
54		-7.200 + 05			
55		-7.900 + 05			
56		-8.200 + 05			
57		-1.050 + 06			
58		-1.150 + 06			
91					
102		4.780 + 06		B ⁻	0.537

PROTACTINIUM Pa

MAT 1297

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-1.870 + 04			
16		-6.656 + 06		B ⁻	0.0668
17		-1.218 + 07			
18					
51		-1.870 + 04			
52		-5.690 + 04			
53		-7.120 + 04			
54		-8.680 + 04			
55		-1.040 + 05			
91		-1.870 + 04			
102		5.197 + 06			

URANIUM-233

 ^{233}U

MAT

1260

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-4.040 + 04			
16		-5.904 + 06			
17		-1.319 + 07			
18					
51		-4.040 + 04			
52		-9.200 + 04			
53		-3.120 + 05			
54		-3.400 + 05			
55		-3.990 + 05			
56		-4.160 + 05			
57		-4.610 + 05			
91					
102		6.800 + 06			

URANIUM-234 ^{234}U

MAT 1043

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-4.400 + 04			
16		-6.771 + 06			
17		-1.267 + 07			
18					
51		-4.400 + 07			
52		-1.440 + 05			
53		-2.970 + 05			
54		-8.000 + 05			
55		-9.450 + 05			
56		-1.035 + 06			
91		-8.950 + 05			
102		5.297 + 06			

URANIUM-235

 ^{235}U

MAT

1261

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
3					
4		-1.300 + 04			
16		-5.306 + 06			
17		-1.215 + 07			
18					
19					
20					
21					
51		-1.300 + 04			
52		-4.960 + 04			
53		-8.360 + 04			
54		-1.025 + 05			
55		-1.492 + 05			
56		-1.720 + 05			
57		-2.340 + 05			
58		-2.680 + 05			
59		-3.980 + 05			
60		-5.970 + 05			
61		-9.958 + 05			
62		-1.992 + 06			
63		-2.987 + 06			
64		-3.983 + 06			
65		-4.979 + 06			
66		-5.975 + 06			
91		-9.459 + 05			
102		6.545 + 06			

URANIUM-236 ^{236}U

MAT 1163

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-4.528 + 04			
16		-6.910 + 06			
17		-1.164 + 07			
18					
51		-4.528 + 04			
52		-1.460 + 05			
53		-2.980 + 05			
54		-6.950 + 05			
55		-9.800 + 05			
56		-1.060 + 06			
91		-8.950 + 05			
102		5.124 + 06			

URANIUM-238

 ^{238}U

MAT

1262

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
3					
4		-4.500 + 04			
16		-6.040 + 06		B ⁻	0.071
17		-1.146 + 07			
18					
19					
20					
21					
38					
51		-4.500 + 04			
52		-1.460 + 05			
53		-3.080 + 05			
54		-6.800 + 05			
55		-7.320 + 05			
56		-8.270 + 05			
57		-9.300 + 05			
58		-9.670 + 05			
59		-1.000 + 06			
60		-1.041 + 06			
61		-1.060 + 06			
62		-1.120 + 06			
63		-1.160 + 06			
64		-1.220 + 06			
65		-1.270 + 06			
66		-1.300 + 06			
67		-1.361 + 06			
68		-1.409 + 06			
69		-1.437 + 06			
70		-1.470 + 06			
71		-1.625 + 06			
72		-1.875 + 06			
73		-1.950 + 06			
74		-2.950 + 06			
75		-3.950 + 06			
76		-4.950 + 06			
91		-4.470 + 04			
102		4.804 + 06			

NEPTUNIUM-237

 ^{237}Np

MAT 1263

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-3.320 + 04			
16		-6.760 + 04			
17		-1.229 + 07			
18					
51		-3.320 + 04			
52		-5.960 + 04			
53		-7.600 + 04			
54		-1.030 + 05			
55		-1.590 + 05			
56		-2.240 + 05			
57		-2.680 + 05			
58		-3.050 + 05			
59		-3.320 + 05			
60		-3.690 + 05			
61		-3.710 + 05			
91		-3.320 + 05			
102		5.490 + 06			

PLUTONIUM-238 ^{238}Pu

MAT 1050

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average Decay Energy
1					
2					
4		-4.410 + 04			
16		-6.930 + 06			
17		-1.291 + 07			
18					
51		-4.410 + 04			
52		-1.458 + 05			
53		-6.050 + 05			
54		-6.720 + 05			
55		-7.550 + 05			
56		-9.370 + 05			
57		-9.850 + 05			
58		-1.030 + 06			
59		-1.070 + 06			
91		-1.195 + 06			
102		5.630 + 06			

PLUTONIUM-239 ^{239}Pu

MAT 1264

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-7.850 + 03			
16		-5.656 + 06			
17		-1.265 + 07			
18					
19					
20					
21					
37					
38					
51		-7.850 + 03			
52		-5.700 + 04			
53		-7.600 + 04			
54		-1.640 + 05			
55		-1.930 + 05			
56		-2.860 + 05			
57		-3.300 + 05			
58		-3.880 + 05			
59		-3.920 + 05			
60		-4.340 + 05			
61		-4.700 + 05			
62		-4.860 + 05			
63		-4.920 + 05			
64		-5.050 + 05			
65		-5.120 + 05			
66		-5.560 + 05			
67		-7.300 + 05			
68		-7.600 + 05			
69		-8.000 + 05			
70		-8.490 + 05			
71		-9.958 + 05			
72		-1.992 + 06			
73		-2.987 + 06			
74		-3.983 + 06			
75		-4.979 + 06			
76		-5.975 + 06			
91		-5.560 + 05			
102		6.533 + 06			

PLUTONIUM-240 ^{240}Pu

MAT 1265

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
4		-4.300 + 04			
16		-6.534 + 06			
17		-1.219 + 07			
18					
19					
20					
21					
51		-4.300 + 04			
52		-1.420 + 05			
53		-2.960 + 05			
54		-5.990 + 05			
55		-8.630 + 05			
56		-9.030 + 05			
57		-9.450 + 05			
58		-1.420 + 06			
59		-2.000 + 06			
60		-3.000 + 06			
61		-4.000 + 06			
62		-5.000 + 06			
91		-9.450 + 05			
102		5.241 + 06			

PLUTONIUM-241 ^{241}Pu

MAT 1266

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-4.000 + 04			
16		-5.220 + 06			
17		-1.168 + 07			
18					
51		-4.000 + 04			
52		-9.500 + 04			
53		-1.630 + 05			
54		-1.690 + 05			
55		-1.740 + 05			
56		-2.310 + 05			
57		-2.450 + 05			
58		-3.000 + 05			
59		-3.350 + 05			
60		-4.480 + 05			
61		-7.530 + 05			
62		-8.280 + 05			
63		-8.940 + 05			
64		-9.180 + 05			
65		-9.410 + 05			
91		-1.195 + 06			
102		6.301 + 06			

PLUTONIUM-242

 ^{242}Pu

MAT

1161

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average Decay Energy
1					
2					
4		-4.490 + 04			
16		-6.240 + 06			
17		-1.178 + 07			
18					
51		-4.490 + 04			
52		-1.490 + 05			
53		-3.120 + 05			
54		-6.470 + 05			
55		-6.970 + 05			
56		-7.960 + 05			
57		-9.650 + 05			
58		-1.010 + 06			
59		-1.060 + 06			
60		-1.110 + 06			
91		-1.195 + 06			
102		5.037 + 06			

AMERICIUM-241

 ^{241}Am

MAT 1056

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	<u>Average Decay Energy</u>
1					
2					
4		-4.150 + 04			
18					
91		-4.195 + 04			
102		5.528 + 06			

AMERICIUM-243

 ^{243}Am

MAT

1057

<u>MT</u>	<u>LR</u>	<u>Q (MT)</u>	<u>Q (LR)</u>	<u>Decay Type</u>	Average <u>Decay Energy</u>
1					
2					
4		-8.340 + 04			
18					
91		-8.390 + 04			
102		5.364 + 06			

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